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Cuvânt înainte

Prezenta carte de limba engleză tehnică – prima pentru domeniul aerospațial – este rodul a peste douăzeci de ani de predare ai autoarei la Facultatea de Inginerie Aerospațială din Universitatea „Politehnica" București.

Cartea se adresează studenților și specialiștilor de profil mecanic și, mai ales, celor care studiază cele trei specialități de bază ale ingineriei aerospațiale: structuri, propulsie și echipamente și instalații de bord.

Conținutul este bogat și relevant, incluzând o varietate de vehicule aerospațiale (avioane, helicoptere și rachete). Părțile lor componente sunt prezentate împreună cu atributele funcționale, rolul și performanțele lor. Paleta largă a structurilor nu este restrânsă doar la aripă, fuselaj și suprafețe de comandă, ci include și elemente de hipersustentație, precum și trenul de aterizare.

Nu sunt evitate nici subiecte teoretice cum ar fi profilul aerodinamic, care fac din această carte un excelent manual de limba engleză tehnică și, în același timp, un ghid atractiv, capabil de a introduce cititorul în atmosfera domeniului interesant al aeronauticii, unde se propun probleme, se sugerează și se dau soluții.

Același lucru se poate afirma și despre capitolul „Sisteme de propulsie", în care autoarea descrie tipurile de motoare folosite astăzi, părțile lor componenete (compresoare, turbine), aspecte speciale ale propulsiei la VTOL și STOL, alături de principii ale termodinamicii (Working Cycles).

Instrumente de zbor, controlul aeronavei precum și al vehiculelor spațiale vin să completeze conținutul cărții.

Ultimele capitole întregesc subiectele tratate cu diverse accidente, sau probleme cum sunt electronica elicopterului, sisteme electrice și infrastructura aeroportuară.

Un bogat material ilustrativ bine selectat din diverse domenii, clar ordonat și reprezentativ ,vine în sprijinul cititorului.

Structuri tipice ale limbajului de specialitate, note explicative, vocabularul de bază precum și o mare varietate de exerciții lexicale și gramaticale fac această carte atractivă și incitantă, ea reprezentând un instrument extrem de util celor interesați.

Recomand cu căldură această remarcabilă lucrare tuturor celor ce vor să-şi completeze şi să-şi consolideze cunoştinţele de limba engleză într-un domeniu de vârf al ştiinţei şi tehnologiei.

Este o carte pentru orice bibliotecă personală.

Prof. dr. ing. **Corneliu Berbente**
Prorector Universitatea „Politehnica" Bucureşti.
Catedra de Ştiinţe Aerospaţiale „Elie Carafoli"

Prefață

Cartea se adresează celor ce doresc să deprindă limbajul de specialitate în domeniul tehnic.

Scopul acestei cărți a fost dictat de necesitatea exprimată de foști studenți ai autoarei (actualmente ingineri care lucrează în diverse firme de profil) să găsească un manual de limbaj specializat care să le permită să stabilească o comunicare eficientă într-un anume context.

*Pornind de la această premisă, limba engleză trebuie privită ca un instrument în achiziționarea cunoștințelor tehnice – **English for Special Purposes**.*

Limba folosită în știință și tehnică nu este diferită de cea folosită în viața de zi cu zi, dar îi ridică o serie de probleme vorbitorului străin.

Prima dificultate recunoscută este cea a vocabularului de specialitate. Din fericire, azi, există numeroase dicționare excelente de termeni tehnici, care pot rezolva în mare măsură această problemă.

*Mult mai dificile sunt însă cuvintele semi-științifice sau semi-tehnice, care au o serie de înțelesuri și sunt des folosite cu sensuri foarte specializate. Cuvinte simple ca **work, plant, load, feed, force** pot duce la multe confuzii, ca să nu mai menționăm verbe (cu prepoziții obligatorii – de exemplu – **hold on, hold off**), adjective și adverbe, care nu sunt specifice limbajului științific, dar aparțin științei.*

*Structurile tipice limbajului de specialitate (**Passives, Contracted Relatives, Explanation of Cause** etc.) prezentate în această carte au ca scop familiarizarea cititorului cu modul de exprimare tipic utilizat de vorbitorul nativ. Cititorul nu trebuie să uite, totuși, că scopul acestei cărți a fost acela de a preda structuri de limbaj de specialitate și nu materii inginerești.*

M-am oprit la limba folosită în domeniul aviației, având în vedere gama largă a vocabularului care cuprinde învelișuri, materiale, instalații de putere, aparatură electronică, echipamente de zbor, dându-i astfel posibilitatea de a folosi structuri de limbă și lexic comune mai multor discipline tehnice.

În același timp, varietatea exercițiilor încearcă să-i ofere cititorului posibilități diverse de însușire a deprinderilor de exprimare într-un limbaj specializat, astfel încât să le poată folosi cu ușurință în situații reale.

Selectarea textelor a constituit obiectul unei cercetări atente pentru a furniza date suficiente identificării structurilor caracteristice registrului lingvistic analizat.

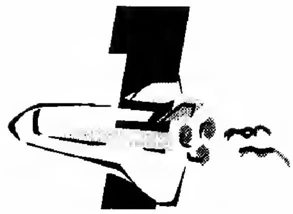
Mulțumesc d-lui profesor dr. ing. Nicolae Vasiliu pentru acel „push“ necesar începerii acestei lucrări, precum și pentru posibilitățile materiale oferite de a o duce la bun sfârșit.

De asemenea, mulțumesc d-lui prof. dr. ing. Șerban Tomescu, prodecanul Facultății de Inginerie Aerospațială, pentru ajutorul și sfaturile primite la alegerea materialului ilustrativ, membrilor Catedrei de Științe Aerospațiale din Universitatea „Politehnica“ București și regretatului profesor dr. doc. Augustin Petre, pentru sugestiile date de-a lungul anilor, care au devenit parte din acest manuscris.

Țin să-mi exprim gratitudinea pentru ajutorul oferit în tehnoredactarea acestei lucrări d-lor asist. drd. Cristian Roșu și ing. drd. Constantin Drăgoi.

Autoarea

Cuprins



Aviation - Highway to the Future

In the dynamic field of today, aviation provides a rapid transportation link between different population centers, complementing a road and rail transportation network. In many places the airplane is the only known vehicle for the large-scale movement of passengers and freight over large distances. The airplane has made it possible to patrol the forest effectively, to fight their fires, to assess their timber resources and to plan their harvesting. It has made an enormous contribution to the photographing and mapping of the vast territories, to exploring and prospecting for mineral wealth, and to studying and assessing water resources. As for the helicopter, this type of aircraft has proved its value in special applications where vertical or near vertical take-off landing and vertical load lifting was required.

The growth in the popularity of the air travel is due to the comfort and services provided by the modern aircraft, to the high speed of reaching the point of destination. The growth in the number of passengers carried by the world's airlines has been tripling every 10 years. It has been predicted that in the third millenium there will be 2,5 to 3 times as many passengers-mile flown and 3 times as many people using air transportation as there are today. As measured by the number of aircraft and pilots employed, civil aviation is expected at latest to double. This expansion of civil aviation will reflect an immense growth in the worldwide business travelling, cargo transportation, and tourism.

Civil airplanes will be continuously improving from the point of view of their speed, comfort and operating cost, but their capital costs will not increase proportionally. Airline fares tend to decrease but better service is being given to passengers.

It has also been predicted that it should be possible to design a supersonic transport that could be economically competitive with subsonic transports. Short take off and landing aircraft dominate the short-haul air routes up to 500 miles. But it is unlikely that vertical take off and landing aircraft will be economically profitable for scheduled flights.

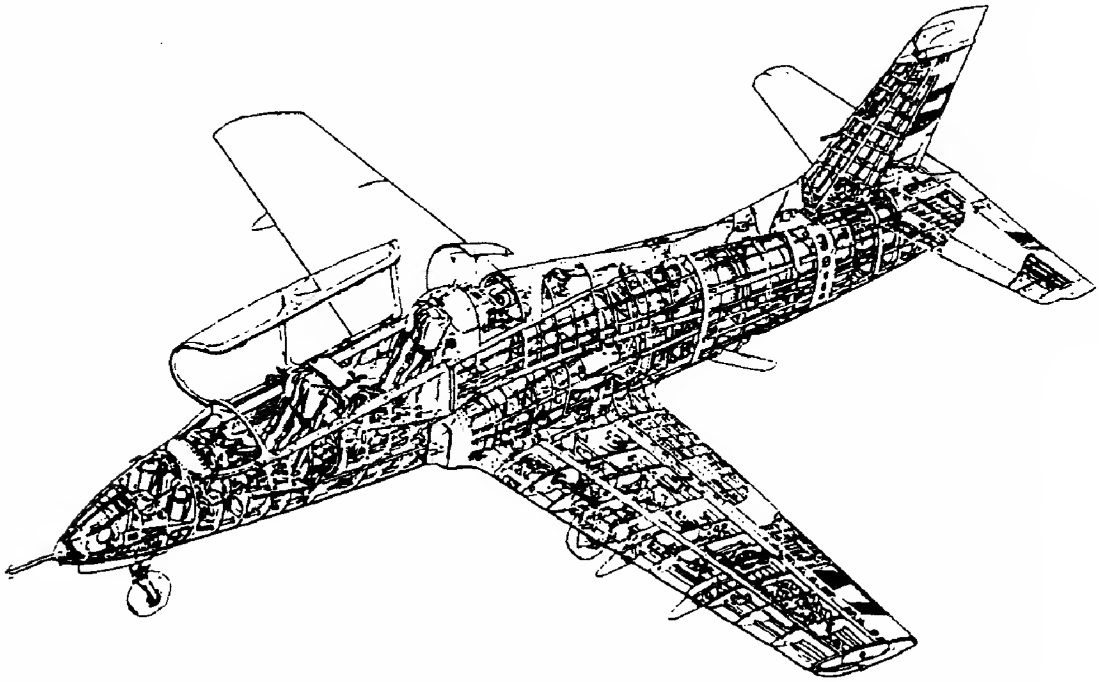


Fig. 1.1. An aircraft overview.

There are no doubts about the continuing importance of aviation and the dynamic nature of its development in succeeding years. Civil aviation will continue to flourish in the years ahead contributing to the economic growth, scientific and technological development, and forming a sound basis for international relationships between countries.

VOCABULARY

freight = marfă
network = rețea
to patrol (r) = a patrula
to asset (r) = a fixa, a stabili o taxă, a evalua
vertical take-off = avion cu decolare verticală
short-haul aircraft = avion scurt curier
medium-haul aircraft = avion mediu curier
long-haul aircraft = avion lung curier

NOTES TO THE TEXT

WORD STUDY

Likely, liable, susceptible

1. The work is **likely to** start next year.
2. The engine will **probably** be a good one.
3. The new aircraft is **liable to** be very expensive.
4. The airflow is **liable** to break up.
5. There is a | risk of an explosion.
   | danger
6. This road is **liable to** frost damage.
7. The region is **susceptible to** earthquakes.

PATTERNS

I. As + Past Participle. Contracted Passive Forms.

a. **As measured** by the number of aircraft and pilots employed, civil aviation is expected to double.

b. **Passive form** (notice that there is no "it" subject).

As is shown in the illustration....
As has been stated before ....
As has been just **proved** ...
As was mentioned a short time ago ...

c. **Active form**

As the illustration on page 246 **shows**...
As we have stated before ...
As we have just **proved** ...

d. **Other contraction**

As above ...
As before ...
As follows ....

II. Comparative

Steel is	as useful as almost as useful as almost as useful as almost as useful a material as	cast iron

Steel is	stronger far stronger slightly stronger more expensive much more expensive	than cast iron

Cast iron is	weaker less expensive a much less expensive material a much less expensive material to produce	than cast iron

Cast iron is	not so expensive not quite so expensive not quite such an expensive material not quite such an expensive material to produce	as steel

III. Should

1. **Instructions to operators**
   The machine **should be handled** with great care.
   Safety precautions **should be observed** at all times.

2. **Specifications** (what is required of something).
   The steel **should not contain** more than 0.5% of carbon.

3. **Expectations** (what is expected to happen).
   This design **should be completed** by the end of the month.

EXERCISES

I. **Comprehension**

1. What does aviation provide in the dynamic world of today?
2. In what way is the airplane used as a vehicle?
3. How can you explain the growth in the popularity of air travel?
4. Will it be possible to design a supersonic transport?

II. **Make up sentences with the following phrases**:
twice as much as, four times as long, as half, as much as.

III. **Translate into Romanian**, paying attention to the different meanings of **as**:

1. The uranium, as used in the reactor, is in the form of a thin rod. 2. As we know, heat is also a form of energy. 3. The aircraft uses kerosene as a fuel. 4. The bridge, as originally planned, would have been too expensive. 5. The plane, as shown in the illustration, costs £ 20,000. 6. The work, as projected, will take ten years to complete. 7. Describe the device as follows. 8. As we have just stated, the metal will resist up to 10,000°C. 9. As has just proved, the short take-off and landing aircraft dominate the short haul air routes up to 500 miles. 10. This device is as useful as this one.

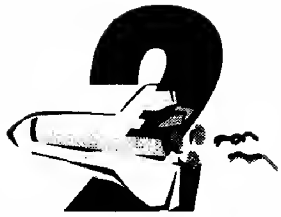
IV. **Join the two statements in each line**, by comparing one with other. Turn the comparison round both ways:

e.g. *A is larger than B*
B is not so large as A

1. The carbon content of mild steel is 0.28%; the carbon of cast steel is 1,2%. 2. Wrought iron contains 0,02% of carbon; it contains 0,02% of magnesium. 3. The temperature in this room is 28°C, the temperature outside the room is 22°C. 4. My radio works very well; my brother's radio works very badly. 5. The journey takes 5 hours by night. 6. This engine needs servicing every 3 months; the latest engine needs servicing every 5 months. 7. Alcohol is not often used in thermometers; mercury is used very often in thermometers. 8. Water boils at 100°C; alcohol boils at 78°C.

V. **Decide on the exacting meaning of *should***, according to pattern III and translate in Romanian:

1. Delivery of the new engines.... (start) by the middle of next year. 2. The motorway...(have) three lanes in each direction with a reservation in the middle. 3. The wing ...(be) capable of withstanding different loads. 4. Construction workers ... (wear) safety helmets at all times. 5. Wear on the bearings ....(reduce) considerably with good lubrication. 6. This experiment .... (give) us the answer to the problem. 7. The material we are looking for .... (capable) of withstanding very high temperatures. 8. The new prototype ... (be) in operation by 1990. 9. Smoking ... (permit) within fifty yards from the hangar. 10. High tensile steel ... (temper) up to 600 C.



2 Structure

Each aeroplane is built according to the definite task with a specific aim of fulfilling clearly outlined mission. This fact governs the difference in the requirements placed upon flying qualities of aeroplanes, their load-carrying capacities, conditioned for accommodation of the crew, passengers, freight and, at last, in the proper conditions of the aeroplane functioning. This difference affects naturally the structural features of aeroplane and their aerodynamic configurations.

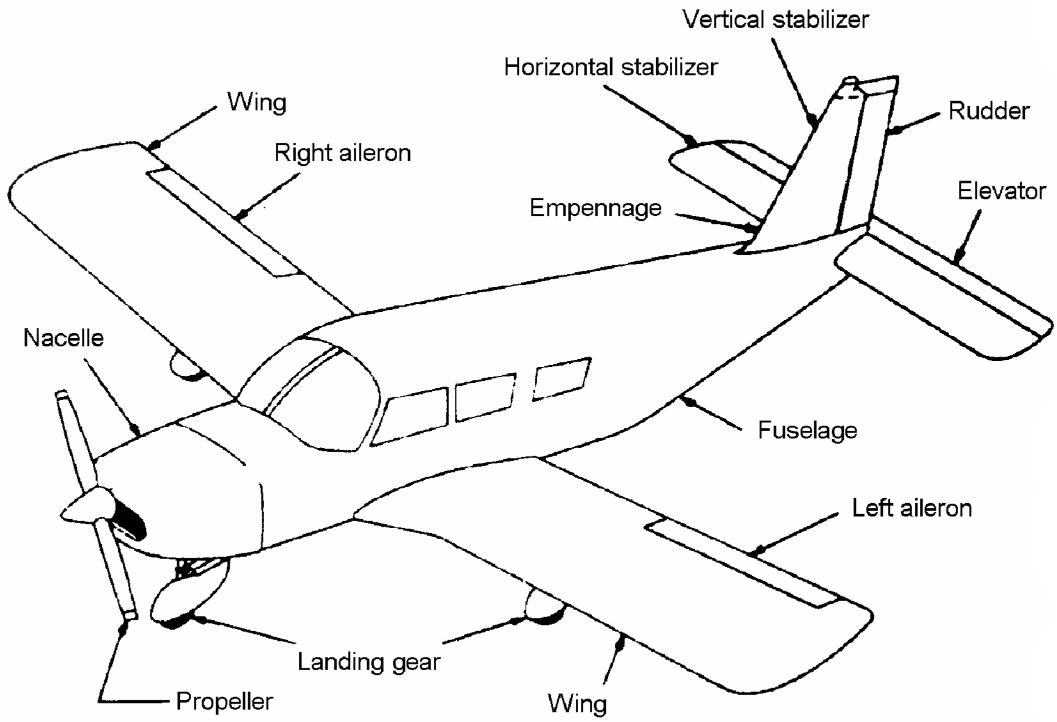


Fig. 2.1. The component parts of an aeroplane with propeller.

Any aeroplane, irrespective of its mission, consists of the following major components: a wing producing lift, a power plant creating thrust, a fuselage providing space for the crew and passengers, freight (and often containing the fuel tanks and power plant), a tail assembly in the form of fixed and movable planes serving to stabilize or change the aeroplane flight altitude, a landing gear, and a control system (fig.2.1, fig. 2.2).

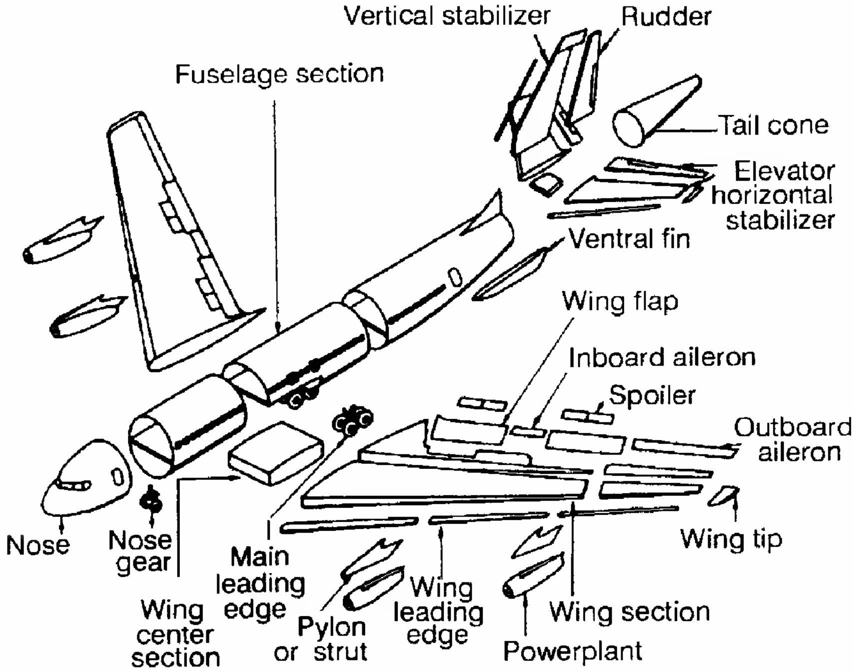


Fig. 2.2. The exploded view of a jet aeroplane.

The wing is the vital component of any flying vehicle. This results from not only its purpose but also from the fact that the wing shares about 12 to 16% of the airplanes weight and up to 50% of the total drag.

The wings of various types of airplanes differ from one another in plan (top view), arrangement relative to the fuselage, dihedral angle (front view), profile, wing loading or special load (i.e., load per square metre of surface), structural features and structural materials.

The wing is used to create a lift force at the expense of the difference in pressures over its upper and under its lower surfaces. Pressure forces are distributed nonuniformly about the airfoil and are applied directly to the skin. Their magnitude changes with each variation in the dynamic head and the angle of attack. Each angle of attack has its individual pressure-distribution pattern and the magnitude of pressure forces and, consequently, its individual lift-drag ratio.

An airflow acting on the wing skin tends to bend the wing both in horizontal and vertical planes, and to twist it. Besides the forces of pressure exerted by the air (i.e., the air load), the so-called mass forces act on the wing; they are essentially the forces of weight of the wing structural members, as well as of the assemblies and loads arranged in the wing, and the inertial forces proportional to the masses of these members. Furthermore, occurring in the points, where the wing is attached to other structural members of the aircraft, are the forces of reaction of the wing interaction with these members. The wing is also designed that with minimum weight it can withstand dynamic loads in flight and retain its aerodynamic shape dependent upon the performance characteristics.

The conventional wing consists of longitudinal structural members: spars and stringers, and transverse members: ribs and skin.

A wing spar is a beam with the upper and lower flanges interconnected by a web or drag struts. The spar vertically transmits the shearing forces to the wing attachments point and receives a bending moment applied to the flanges. Conventional wings may be of three general types: monospar, two-spar and multispar (fig.2.3).

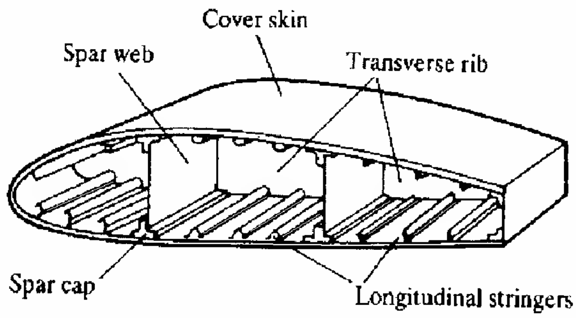


Fig. 2.3. Cross-section through a wing.

Stringers are longitudinal members which are attached to the wing upper and lower skin to make it stiff and enable it to withstand stresses exerted by vertical forces.

Ribs are the basic members used to give the wing section its aerodynamic shape. It is directly to the ribs and via the stringers that the skin is attached. The ribs take the air load and transmit it to the spar. On the whole, the wing members form a thin-walled closed structure consisting of the framework and the skin working side by side.

The higher the aeroplane flying speed, the higher the dynamic head and, consequently, the higher the load on the structural members of the aeroplane. To ensure the required strength and rigidity, the skin of the wing,

empennage, and the fuselage should be thickened and other members of the airplane structure, strengthened. To prevent the wing skin from losing its stability in the gap between the ribs, it is strengthened by longitudinal members – stringers. With this object in view, the honeycomb construction and other structures are employed.

Arranged on the wing are ailerons, which control the aeroplane movement about the longitudinal axis and the high-lift devices, movable leading edges, flaps and trailing-edge flaps and the boundary-layer blow-off or suction gear.

VOCABULARY

airfoil = profil aerodinamic
lift = forța ascensională
drag = rezistența la înaintare
spar = lonjeron
stringer = lisa
rib = nervură
web = "inima", partea interioară a unui longeron
beam = grinda supusă la încovoiere
bar = bară supusă la întindere şi răsucire
column = bară supusă la flambaj
truss = bară articulată la capete
shearing force = forță tăietoare
stress = tensiune
strain = deformație specifică
shearing stress = tensiune tangențială
slat = volet anterior
trailing edge = bord de fugă
leading edge = bord de atac

NOTES TO THE TEXT

WORD STUDY

Types of wings

cambered wing = aripă curbată
double chambered wing = aripă dublu curbată

delta wing = aripă delta
port wing = aripă stânga
starboard wing = aripă dreaptă
wept wing = aripă în săgeată
tapered wing = aripă trapezoidală
double wedge wing = aripă romboidală
multi – rib wing = aripă cu multe nervuri
multi – spar wing = aripă cu multe lonjeroane
nose – slot wing = aripă cu fante frontale
wing setting = calajul aripii

Load

That truck carries a maximum **load** of five tons.
This aircraft carries a very large **payload** of its size.
The bridge cables carry the **dead load** of the deck and suspenders, plus the **live load** of the traffic moving over the deck.
The wire undergoes a **breaking load** test to determine its ultimate tensile strength.
The machine should be tested under normal **load** conditions.

PATTERNS

I. Speed, velocity, rate

The	speed of the velocity	aircraft fluid gas	increases rises decreases falls

The aircraft	increases speed speeds up accelerates decreases speed in reduction reduces speed slows down decelerates

There is	a(n) increase decrease in speed reduction

The rate of descent is increasing.

II. **Dependence**

a) Each airplane is built **according to** / **depending on** the definite task.

b) The size of the engine **depends on** / **is dependent on** the amount of power it has to produce.

The aircraft **depends on** / **is dependent on** its wings and engines to provide lift.

c) Any airplane, **irrespective of** its mission, consists of the same major components.

But **notice** the slight different meaning:

d) The aircraft is **dependable (reliable)**. You can **depend on** (rely on) it. It will not break down.

EXERCISES

I. **Comprehension**

Enlarge upon the following ***key words***:

a) air transport, cargo transport, commercial transport, freight transport, passenger/cargo transport.
b) Types of loads on the wing.

II. **Re-phrase** according to the model:

Structures used in engineering - engineering structures.

Factor providing safety, strength that yields, assemblies of landing gear, failure occurring at low stresses, tip of a crack, pipeline for natural gases, tanks for storage of gasoline.

III. **Complete these statements** with the appropriate word or words:

1. The depth of the road surface will .... the volume of traffic it carries. 2. The motor be large or small, ... the amount of power it has to give. 3. The value of the metal ...... whether it is rare or abundant. 4.The angle of

refraction of light .... the angle of incidence. 5. The passengers .... the pilot and navigator for their safety. 6. Progress with nuclear reactors will ... solving many engineering problems. 7. The rise in pressure .... the speed of rotation of the pump.

IV. **Change into questions** and then translate into Romanian:

1. Stresses and deflections are calculated as functions of the loads imposed upon them. 2. A steel beam of the same dimension and of the same loads have the same stresses. 3. Simplified bodies such as plates, shells and beams are idealized structural elements. 4. Steel can be broken more easily by alternating or reversing stresses. 5. For most ductile materials the yield point is approximately equal to the fatigue strength. 6. Buckling can also lead to structure failure. 7. A long column will buckle out sidewise.

V. **Give an oral account**:

The airplane industry is a mass production industry and therefore the structural layout of the wing must take into account production methods. The general tendency is to design the wing and body structure, so that sub-assemblies of the various parts can be made, which are finally brought together to form the final assembly of the wing panel. Two major strength requirements must be satisfied into the structural design of the wing. These are: 1) Under the **applied** or **limit loads**, no part of the structure must be stressed beyond the yield stress of the material. The terms **applied** or **limit** refer to the same loads, which are the maximum loads that the airplane should encounter during its lifetime of operations. 2) The structure shall also carry **Design Loads** without rupture or failure. The magnitude of the **Design Loads** equals the **Applied Loads** times a factor of safety. In general, the factor of safety for aircraft is 1.5, thus the structure must withstand 1.5 times the applied loads without failure. Aircraft factors of safety are rather low compared to other fields of structural design, chiefly because weight saving is so important in obtaining a useful transportation vehicle relative to useful loads and performance.

VI. **Translate into English**, using the "*for...to*" construction.

Model: *It has been necessary* ***for*** *scientists and engineers* ***to*** *develop new methods of tests.*

1. Este foarte important ca pilotul să cunoască construcția avionului. 2. Soarele este o sursă de energie care dă posibilitate omului să trăiască pe pământ. 3. Zgomotul motoarelor era atât de puternic, încât era imposibil ca pasagerii să vorbească unul cu altul. 4. Poate exista necesitatea ca pilotul să reducă viteza avionului. 5. Este bine să se folosească matrici simetrice pentru probleme ce se rezolvă pe calculatoare mari. 6. Această valoare trebuie să fie negativă pentru ca ecuația (5) să fie valabilă. 7. Reglarea temperaturii trebuie făcută cu grijă pentru ca sistemul să funcționeze corect.

3 Wing

For aerodynamic reasons, the wing cross-section must have a streamlined shape, commonly referred to as an **airfoil** section. The aerodynamic forces in flight change in magnitude, direction and location. Likewise in the various landing operations, the loads change in magnitude, direction and location, thus the required structure must be one that can efficiently resist loads causing combined tension compression, torsion and bending. To provide torsion resistance, a portion of the airfoil surface can be covered with a metal skin, and then adding one or more internal webs to produce a single closed cell or a multiple cell-in wing cross section (fig.3.1).

The external skin surface, which is relatively thin for subsonic aircraft, is efficient for resisting torsional shear stresses and tension, but quite inefficient in resisting compressive stresses due to bending of the wing.

To provide strength efficiency, spanwise stiffening units, commonly referred as flange stringers, are attached to the inside of the surface skin. To hold the skin surface to the airfoil shape and to transfer large concentrated loads into the cellular beam structures, heavy ribs (commonly referred as bulkheads) are used. The ribs act as a transfer or distribution unit. They can vary from a very light structure to a heavy one, which must receive and transmit transfer loads involving thousands of pounds. Since the airplane control surfaces (vertical and horizontal stabilizer) are nothing more than small size wings, internal ribs are likewise needed in this structure.

Up until World War II, practically all airplanes were assumed to be rigid bodies. During the war, failure of aircraft occurred under load conditions, which the conventional design procedures based on rigid body analysis indicated satisfactory. The failures were no doubt, due to dynamic overstresses, because the airplane is not a rigid body. Furthermore, the airplane design progress has resulted in thin wings and relatively large wing

spans and in many cases these wings carry concentrated masses such as power plants, bombs, wing tip fuel tanks, etc. Thus the flexibility of the wings has increased, which means the bending natural frequencies have decreased. This fact, together with the fact that airplane speeds have greatly increased, and thus cause air gust to be applied more rapidly, or the loading is becoming more dynamic in character and thus the overall load effect on the structure is appreciable and cannot be neglected in the strength design of the wing.

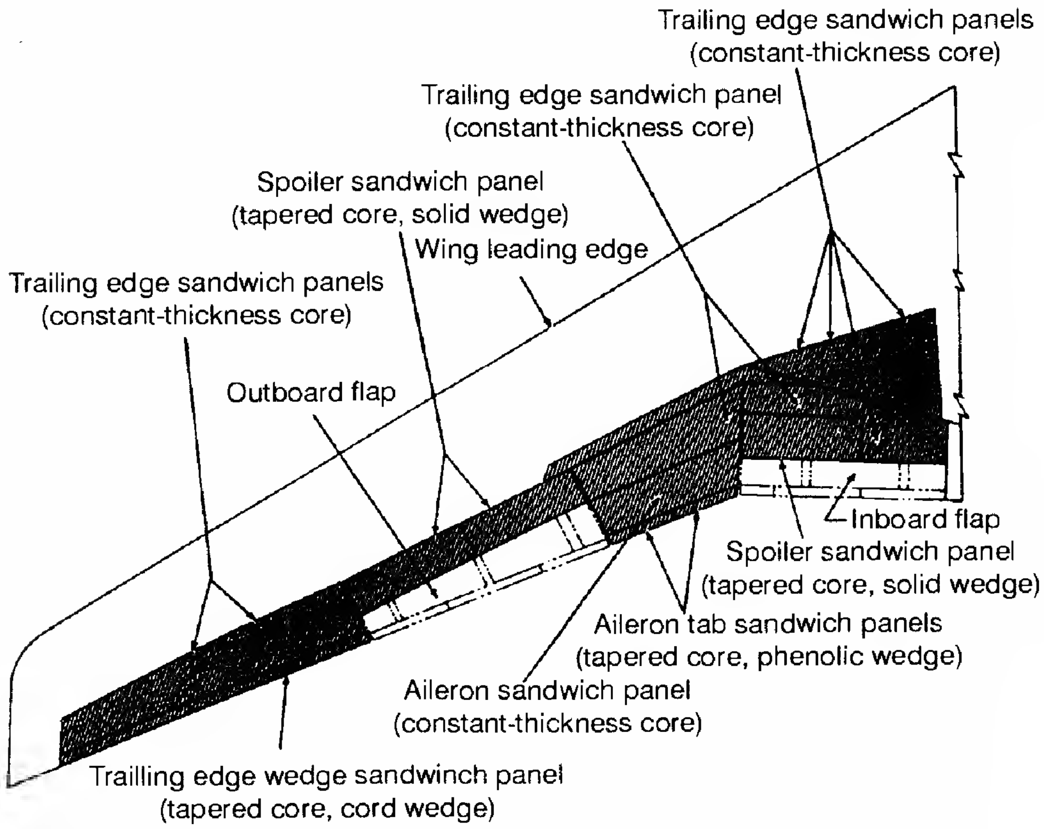


Fig. 3.1. Honeycomb wing construction on a large jet transport aircraft.

The advent of the turbo-jet and the rocket type engines has opened up a range of possible airplane airspeeds hardly dreamed of only a few years ago, and already transonic and supersonic speed airplanes are a common development. From an aerodynamic standpoint, such speeds have dictated a thin airfoil section that has thus promoted a high-density wing.

Thus, for airplanes with appreciable wingspans and near future jet commercial transports, the assumption that the plane is a rigid body is not sufficiently accurate enough, because the dynamic stresses are appreciable. The calculation of the dynamic loading on the wing requires that the mass and stiffness distribution of the wing structure be known. Since these factors are not known when the structural design of a wing is started, the general procedure would be first base the design on the assumption that the wing is a rigid body, plus correction factors, based on past experience or available research information to approximately take care of the influence of the elastic wing on the airplane aerodynamic characteristics.

To withstand the high surface pressures and to obtain sufficient strength much thicker wing skins are usually necessary. Modern milling machines permit tapering of skin thickness (fig. 3.2).

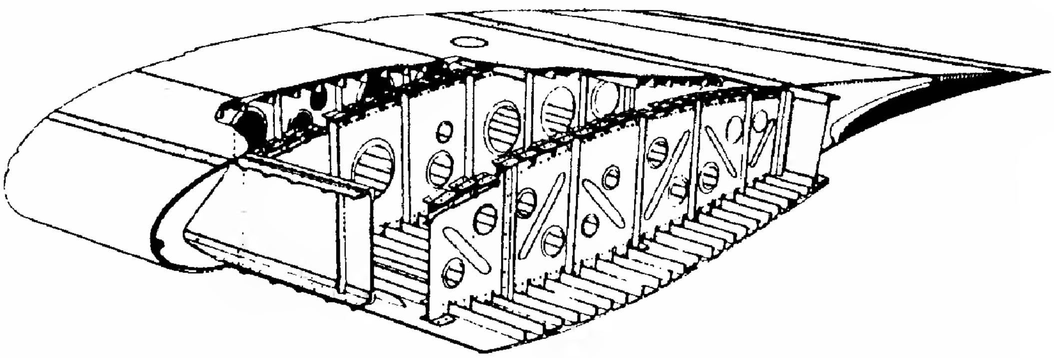


Fig. 3.2. All-metal wing with chemically milled channels.

In a cantilevered wing, the wing bending moment's decrease rapidly spanwise from the maximum values at the fuselage support points. Thus the skin construction must be rapidly tapered to thin skin for weight efficiency, but thinner skins decrease allowable compressive stresses.

To promote better efficiency, a sandwich-construction can be used in the outer portion of the wing (fig. 3.3). A lightweight sandwich core is glued to the thin skin and thus the thin skin is capable of resisting high compressive stresses since the core prevents sheet from buckling. Concentrated external loads must be distributed to the rib before the rib can transfer the load to the wing beam structure.

In other words, a concentrated load applied directly to the edge of the thin sheet would cause the sheet to buckle or cripple under the localized stress. Thus a structural element is fastened to the web, and the concentrated load goes into the stiffener, which in turn transfers the load to the web.

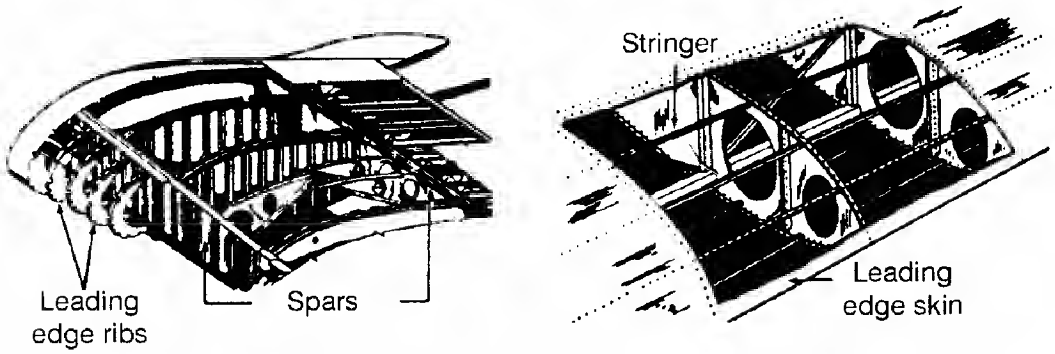


Fig. 3.3. Internal wing construction.

VOCABULARY

streamlined shape = format aerodinamic
bending = încovoiere
shear stress = tensiune tangențială
span = anvergură de aripă
spanwise stiffening units = unități de rigidizare de-a lungul aripii
flange stringers = lise cu proeminențe
bulkhead = nervură masivă, perete despărțitor
tapered airfoil = profil trapezoidal
stabilizer = ampenaj orizontal fix
gust = rafală de vânt
cantilever = grindă în consolă
core = miez
to glue (r) = a lipi
to buckle (r) = a flamba

NOTES TO THE TEXT

WORD STUDY

I. **Core** – heart, or centre

The iron bar at the centre of a solenoid is called a **core.**
Cables can be made of aluminum with a thin **core** of steel wire.
The **core** of an apple, the **core** of a problem.

II. **Range**

Up in the plane he admired the long **ranges** of mountains.
The **range** of temperature should be checked regularly at the right intervals.
I found her **ranging** the books by size.
The temperature in this country **ranges** from 35°C to 0°C.
Unfortunately he can not **range** with our best students.

PATTERN

Uses of the Present Perfect Tense

a) In structures where describe an event ***before the present*** but at no specific or definite time.

Work **has been started** on the new system.

b) In structures which describes an event or series happening ***continuously or repeatedly*** up to the present.

Various types of wings **have been designed** for different purposes.
Engineers **have encountered** many problems with this material.

c) In structures associated with ***already, not yet, for, since***.

Work on the motorway **has not been completed**.
has not already been completed
has been going on since 1958.

Tests so far **have indicated** the presence of large oil deposits.

d) In structures associated with ***just, recently, lately***.

The company **has** just **developed** a new type of aircraft.

EXERCISES

I. **Comprehension**

1. What is an airfoil section?
2. What stiffening units are used to provide strength efficiency?
3. Speak about the progressing of the wing design after the World War II.

II. Translate into English paying attention to the ***Nominative + Infinitive Construction***:

1. Întotdeauna s-a considerat că aceste dimensiuni sunt neglijabile în raport cu celelalte. 2. S-a constatat că există pentru fiecare material o anumită valoare a rezistenței la oboseală. 3. Se susține că acest proces a fost aplicat cu succes la toate tipurile de oțel forjat. 4. S-a considerat că aripa este un corp rigid. 5. Se ştie că tensiunile tangențiale produse la răsucirea unei bare de secțiune transversală circulară sunt proporționale cu momentul de răsucire şi invers proporționale cu modulul de rezistență polar (polar section modulus). 6. La solicitarea de încovoiere simplă s-a constatat că tensiunile normale sunt distribuite liniar pe secțiunea piesei. 7. Se ştie că ipoteza secțiunii plane a lui Bernoulli nu mai este valabilă atunci când înălțimea unei bare solicitate la încovoiere este comparabilă cu lungimea. 8. În acest caz
s-a observat că distribuția neuniformă a tensiunilor tangențiale pe secțiune produce o deplanare (wrapping) a secțiunii transversale. 9. Pentru scopuri ilustrative se consideră că plasma constă din trei fluide. 10. Se consideră că numai energia nucleară este sursa cea mai importantă de energie calorică.

IV. **Put the verb in brackets** at the right tense:

1.The presence of large coal deposits .... (prove) by preliminary surveys. 2. These experiments.....(have) interesting results. 3. The engine, which ....(design) primarily for aircraft, may also prove suitable for other purpose. 4. Flying tests ....(not yet complete) on the prototype machine.5. The first steam engine ....(build) about the hundred years ago, and since that time steam .....(become) the most important single source of power that man .....(ever know). 6. Considerable care ....(take) to ensure the greatest reliability in performance. 7. Steam which ......(condense) in the condenser can be passed back to the boiler for re-use as feed water. 8. This type of valve ....(prove) very satisfactory over a great many years. 9. The steam which ....(exhaust) from the turbine is then condensed.

4 High Lift Devices

The high-lift devices increase the lift force and at the same time the resistance to the aeroplane movement (the drag movement). An increase in the lift force is required in take-off so as to reduce the unstick speed and the take-off run, and in landing, to decrease the landing speed and, as a result of this and the increased drag, to shorten the landing run.

There are several methods of increasing the wing lift with the flying speed being variable. For example, one may increase the wing area or the wing angle of attack, or may vary the wing camber so as to increase the lift coefficient C_y at the same angle of attack.

The first method is so far very rarely used in practice due to the structural complexity. The second method, i.e., increasing the critical angle of attack (which is possible when using leading edge slats) is less effective, because the aeroplane needs to be provided with a high landing gear. The third method, i.e., increasing the curvature (camber) of the wing section, is achieved through deflecting either the leading edge of the wing or its trailing edge flap, or special flaps located on the lower surface of the wing, or through a combined employment of the above mentioned means. This increases the differences between the pressure forces over the upper and beneath the lower surfaces of the wing. As a result, the lift coefficient C_y increases at the same angle of attack.

The wing lift may be also increased through the boundary layer blow-off or suction from the upper surface of the wing or by using jet flaps. However, the use of these means requires greater expenditure of energy.

The high lift devices should be designed so that, when idling, they offer the resistance to the airplane movement, and when operable, they do not produce such changes in the aeroplane behaviour that it would be difficult for the pilot to cope with.

Let us consider the operation of these devices singly. The wing leading edge deflection at high angles of attack impedes the stall, thus enabling one to attain higher angles of attack
and, accordingly, higher lift coefficients C_y. An increase in the wing section curvature, thus obtained, results in the additional increase of the lift coefficient. Since in the wing section with a sharp leading edge (which is used for the wing of high, speed airplanes) the stall develops even at low angles of attack, such wings, in the majority of cases, are made with a hinged leading edge (fig. 4.1).

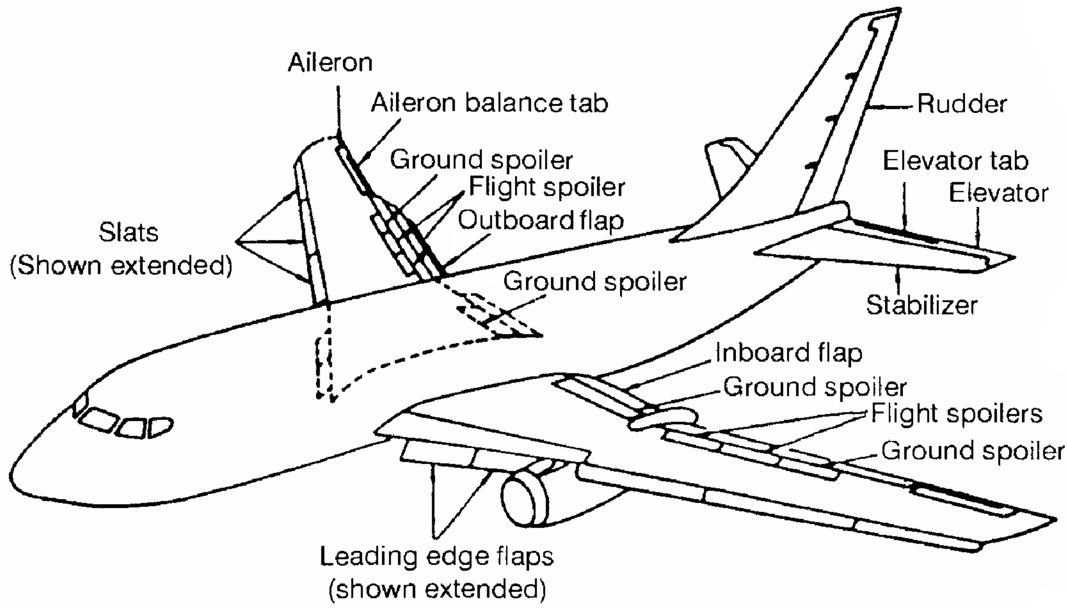


Fig. 4.1. Typical jet transport flight control surfaces.

The leading edge slats are essentially small movable auxiliary airfoils attached to the leading edge of a wing, which, when closed, fall within the original contour of the main wing and, when opened, form a slot. The air, passing through this slot, flows over the upper surface of the wing, thus blowing off the boundary layer. As a result, the stall is delayed to much higher angles of attack with a corresponding rise in lift coefficient C_y.

The slats have been usually used only for enhancing the aeroplane lateral stability when flying at high angles of attack. Slats can be fixed in relation to the wing (i.e., with a permanent slot in the airfoil) or movable (i.e., slats are forced against the wing when flying at low angles of attack) (fig. 4.2).

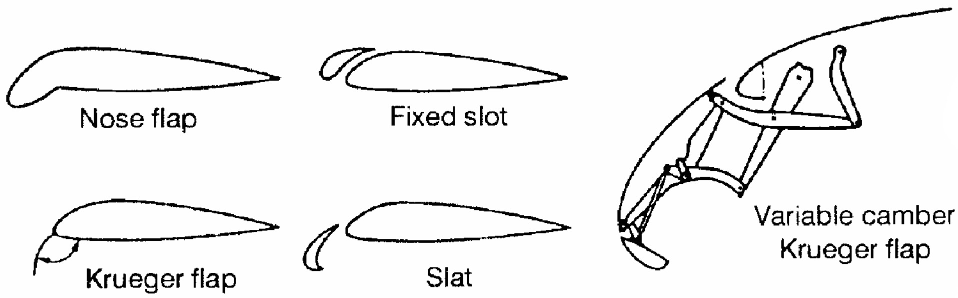


Fig. 4.2. Various leading-edge flap configurations.

The trailing edge high lift devices allow one to enhance the lift coefficient without increasing the angle of attack. The simpliest type is a split flap, which is actually a part of the lower surface of the aerofoil that may be lowered to 55–60°.

The split flap takes 25–30 % of the chord and up to 60% of the aeroplane wingspan.

The extension flaps are structurally more complicated than the split flaps. They can move downward and simultaneously extend rearward along the chord line, thus somewhat increasing the effective area of the wing.

VOCABULARY

unstick speed = viteză minimă
camber = curbură
idling = mers în gol, relanti
to cope (r) with = a face față
to impede (r) = a impiedica, a stânjeni
stall = angajare în limita de viteză, pierdere de viteză
hinged = articulat
slat = volet anterior
slot = fantă
split flap = volet de intrados
to enhance (r) = a spori, a intensifica

NOTES TO THE TEXT

WORD STUDY

Means, method, way

Means, as a noun, ***is the same*** both singular and plural
Mean as adjective is "meschin"

There are several	means	to increase the wing lift
	methods	
	ways	

Mind: **By means of** cannot be used before a Participle, only **by** is possible in such a case. Sometimes it is possible to use "**with**" instead of "**by**" before a noun. "**With**" really means "**with the help of**", and there is a slight difference in meaning: it is not advisable to use "**with**" unless the meaning is truly instrumental.

The runway was cleared **by** (means of) a bulldozer.
The runway was cleared **with** (the help of) a bulldozer.

PATTERN

Contracted time statement

Slats are forced against the wing when **flying** at low angles of attack/while it is flying.

> *When, on, before, while+ing – when the subject is the same*

Here are different possibilities of the structure:

Before
Prior to
entering the nozzle, the steam is at high pressure.

When
While
In

flying at light angles of attack, slats have usually been used only for enhancing the airplane lateral stability.

After
On

leaving the blades, the steam passes out to the atmosphere.

EXERCISES

I. **Comprehension**

1. Speak about leading edge slats.
2. Define the trailing edge high lift devices and split flaps.

II. **Impersonal Constructions**

Model: ***One may increase*** the wing area using several methods.
It is possible to use .....
There can be used ....

a. Use the above pattern in making sentences of your own.

b. Complete the sentences:

One assumes that ....
One believes that ....
One may conclude that ......
One should expect that ......
One must note that ....
One will obtain that ....

III. **Use the contracted structure** to re-write the following statements:

1. The aircraft exploded as it was landing. 2. Before the production starts, extensive tests must be made. 3. While the engine was being examined, a number of defects were found. 4. As they rotate, the pulverizers break up the

coal into fragments. 5. When high lift devices operate, they do not produce such changes in the airplane behaviour. 6. The structure of the metal begins to change as soon as it exceeds the critical temperature. 7. When we discuss high speed aerodynamics, we constantly refer to the speed of sound. 8. When we describe a turbo-prop, the accepted unit for measuring the rate of doing work is horsepower. 9. When we deal with astronomical distances we find the change in gravity to be very significant. 10. While it is coasting in Keppler orbits, liquid propellant floats in the tank. 11. When we apply these two methods, consideration should be given to the physical phenomenon.

IV. **Translate into Romanian**, paying attention to the different meanings of ***one***:

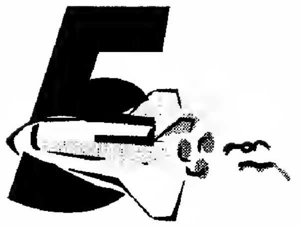
The liquid rocket unit comprises two rocket engines – the main and the reserve **one**. The landing process of a spacecraft comprises two stages. The first stage involves departure from the orbit. The second **one** consists of re-entry into dense atmosphere and soft landing. To characterize the rocket **one** has to state whether the rocket is equipped with a solid or a liquid propellant engine, whether the rocket is guided or unguided. There exists a severe problem of returning from space for all manned vehicles and for some unnamed **ones**. Lack of weight is **one** of the many problems with which spacemen must cope.

V. **Put the verb in brackets** at the correct tense and voice:

1. A great deal of information ...... already (to obtain) about meteors from visual and photographic observations. 2. Within the past few years great advances ... (to make) in the technique of programming computers. 3. While the experiment .... (to carry out) nobody ... (to leave) the lab. 4. The visible side of the Moon ....(to study) ever since Galileo Galilei ... (to invent) the telescope. 5. For a long time Venus..... (to study) by astronomers, yet less....(to know) about this planet than about any other planet in the solar system because the observation ...(to be) difficult. 7. Automatic interplanetary station ...(to sent) to the Moon, Venus and Mars. 8. By the end of the year the construction of this power plant..... (to complete). 9. This ammeter..... (to be able to rely upon) because .... (to be) not accurate enough. 10. Throughout the physical training, the astronauts..... (to teach) a variety of special subjects.

VI. **Translate into Romanian**:

A jet flap is another means of increasing the lift force. This is essentially the air or gas supply through a special slot in the trailing edge of a wing, at some angle to the chord. A jet from the slot plays the role of a peculiar flap. The air flows as if streamlines some dummy wing having a larger chord and curvature than a real one. The pressure distribution over the real wing changes and its lifting ability (mainly in the trailing edge area) increases. The jet flap has not gained wide acceptance because of the great weight of the gas supply system and difficult maintenance.



5 Fuselage

The fuselage is the body to which are attached several principal parts of an aeroplane: the wing, empennage, landing gear and power plant. The fuselage provides spaces for the crew, passengers, equipment, cargo, and, in some cases, contains the fuel and the oil tanks, armament.

Considerable loads act upon the fuselage because of the aeroplane parts jointed thereto, the weight of cargoes arranged inside its cargo compartment, and the weight of its own structure. Also acting on the fuselage are surface aerodynamic forces (pressure and rarefaction). The latter may be as great as 7,000 kgf/m^2 in magnitude in some points of the fuselage.

The pressurized fuselages are additionally loaded internally with excessive pressure, as the pressure inside them is higher than the outside air pressure.

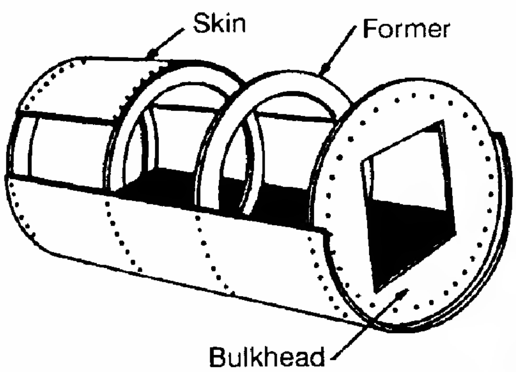


Fig. 5.1. Monocoque construction.

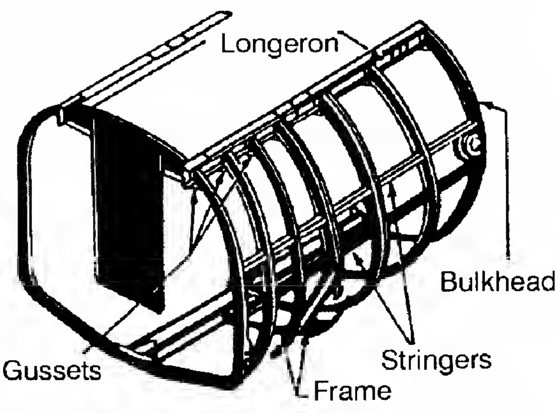


Fig. 5.2. Fuselage structural members.

The fuselage of a modern aeroplane is essentially a framework covered with a thin walled skin. Like the wing, it is subject to bending and twisting. The framework consists of longitudinal members (stringers and longerons) and transversal members (frames) (fig. 5.1, fig. 5.2).

The stringers and longerons are loaded with axial forces (tensile or compressive force) due to the fuselage bending moments. The stringers also serve to stiffen the skin, thus preventing it from buckling under severe stress. The frames are used to maintain the circular cross section of the fuselage. They serve as support for the stringers and skin, and to take the aerodynamic load. The strong frames transmit local concentrated forces to the skin.

The skin provides a streamlined shape to the fuselage. It is exposed to normal compressive and tensile stresses, as well as to shear ones that occur in the fuselage bending and twisting (fig. 5.3, fig. 5.4).

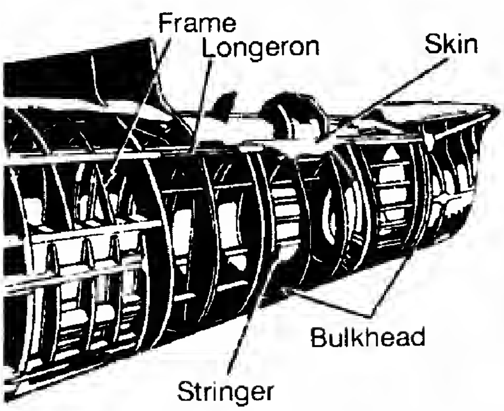


Fig. 5.3. The fuselage terminates in a tail cone.

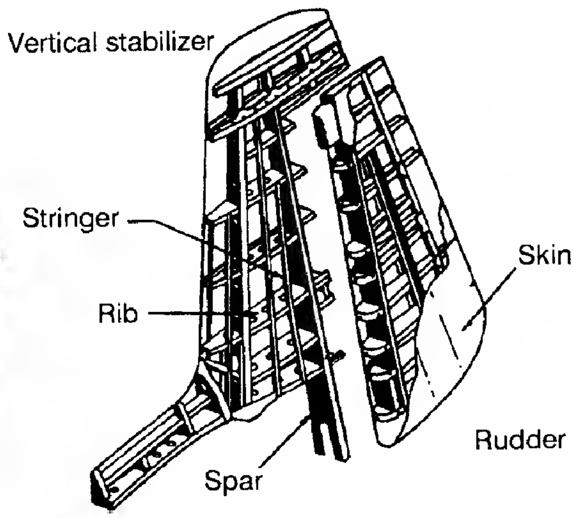


Fig. 5.4. Construction features of rudder and vertical stabilizer.

It is essential for the fuselage to have many large cutouts to gain access to the aircraft equipment and cargoes. The fuselage is also provided with bomb bays, cabins, armament, doors, landing gear, etc.

The fuselage nose section of a supersonic airplane is made pointed to afford the formation of oblique shock waves in view of decreasing wave drag.

Pressurized cabins are used to provide life conditions for the crew and passengers at high altitudes of flight. A higher oxygen-enriched air pressure (in relation to the atmospheric pressure at a given flight altitude) is created in these cabins. Normal temperature is maintained owing to the thermal insulation and installation of heating and cooling equipment. The cabin windows and canopy are the most vital parts of the pressurized cabin. While flying at low air temperatures, the cabin windows glass panels may become fogged or frozen, thus obstructing visibility. Therefore, the windows are either electrically heated or hot air is supplied to them, or a double glass panelling is made with an air interlayer, which is dehumidified by means of special devices.

VOCABULARY

thereto = la aceasta
rarefaction = rarefiere
frame = cadru, schelet, carcasă
to buckle (r)= a flamba
to stiffen (r)= a rigidiza
streamline = linie aerodinamică
cut-out = decupare
bomb bay = camera de bombe, lăcaşul bombei
insulation = izolație

NOTES TO THE TEXT

WORD STUDY

To supply, to provide, to fit, to endow, to equip

The compressor **supplies** compressed air to the engine.
The fuselage **provides** spaces for the crew, passengers, equipment and cargo.
Cold water is **supplied** to the condenser.
Drains are **provided** on the casing.
Pipes are **fitted with** expansion joints.

The fuselage is **provided** with landing gears.
fitted
equipped
endowed

PATTERNS

I. **Explanation of Cause**

The pressurized fuselages are additionally loaded internally with pressure,
as the pressure inside them is higher than the outside pressure.
since
because

In this statement the part, which begins with **as**, **since** is a clause explaining why the event took place. The common "cause words" used in this structure are:

In view of the fact that **On accounting of the fact that** **Owing to the fact that** **Seeing that**	the pressure is higher, the pressurized fuselages are additionally loaded internally with excessive pressure

II. **Impersonal Introduction**:

It (is) + adj + that ***verb***

It is | likely
possible
evident
obvious
clear
desirable
essential
that the fuselage to have large cut-outs.

It should | noted
realized

It will be | noticed
seen
appreciated
that this energy cannot be destroyed

It can be	shown proved demonstrated	that this energy cannot be destroyed
It is	known assumed	that production should begin in a few months.

EXERCISES

I. Comprehension

Describe the fuselage using the following ***key words***:

Aft fuselage, centre fuselage, drooping-nose fuselage, front fuselage, lift fuselage, monocoque fuselage, pressurized fuselage, rear fuselage, semimonocoque fuselage, sharp-nosed fuselage, sound-proofed fuselage, supersonic fuselage; aft cabin, air-conditioned cabin, baggage cabin, cargo cabin, clear-view cabin, crew cabin, enclosed cabin, hermetic cabin, passenger cabin, pilot's cabin, sound proofed cabin, single-seat cabin, two-seat cabin.

II. **Translate into Romanian**:

1.I heard he was at **bay**. 2. "Stand at **bay**", he was asked. 3. His enemies brought him to **bay**. 4. They tired to keep **bay**. 5. Its **bay** sounded in the house. 6. The **Bay** State is facing the Atlantic. 7. Those **bays** have to be reinforced. 8. Horses stood silently in their **bays**. 9. That **bay** is my favorite horse. 10. His train reached the **bay**.

III. **Fill in** with the appropriate verb:

1. Our workshop will have to ... an increased number of high standard machines and equipment. 2. It is necessary to ... Romanian products with higher technical and qualitative parameters. 3. A wide range of consumer goods will be ... to fully meet the customers'need. 4. Solar energy converters ... with large mirrors. 5. Supersonic jets ... special cooling equipment. 6. Landing gear struts .... with shock absorbers. 7. To prevent fretting corrosion, special fittings .... for the attachment of the forward wing. 8. A plane ... with a three - wheel landing may execute a ground loop about its vertical axis or nose over. 9. In the case of retractable landing gears, when the wheels are retracted, they have to be ... into the space available in

the wing or fuselage. 10. A wind tunnel of the Eiffel open circuit type may be .....

IV. **Use "cause words"** to link these statements:

1. The temperatures reached are very high. Some method of cooling must be adopted. 2. This turbine is very widely used. It has a much greater efficiency. 3. Metal expands when it is heated. Expansion joints are fitted to steam pipes. 4. Vertical boilers were installed in the factory. Only a limited floor space was available. 5. Gas turbines are not self-starting. A starting motor must be fitted to drive the compressor. 6. The apprentices had very little training. Their work was very poor. 7. Exhaust gases still possess a great deal of heat. They can be used to heat the incoming air to the boiler. 8. The steam from the boiler is wet. It has to be passed through the super heater. 9. The neutron is an uncharged particle. No repulsive forces are exerted on it by the nucleus. 10. Work is the product of two scalar quantities. It is a scalar quantity. 11. The temperature of the body is raised. The body emits invisible radiations. 12. Most of the fatigues fractures start on the surface. The condition of the surface is of primary importance if fatigue failures are to be avoided. 13. All gases expand equally. The same rise in temperature means the same increase of energy.

V. **Add an impersonal introduction** to these statements:

......the machine should be tested under conditions which approximate as closely as possible to normal. 2. .... some substances which are insulators at normal temperature become conductors if they are sufficiently heated. 3. .... particles in solution carry the current through the liquid. 4. ...the Carnot cycle has the highest thermal efficiency of all gases. 5. ... the mass of the nucleus represents almost the whole mass of the atom. 6. .... the modulus of elasticity is expressed in the same units as the stress. 7. ....the motor cycle should be kept in motion as long as the engine is running, otherwise overheating of the engine will result. 8. ... one material to show a moderate increase in friction as temperature increases. 9. ... to use desiccators to dehumidify airplane windows. 10. ... to use computers nowadays.

VI. **Translate into English**:

Aeroplanul "A.Vlaicu III" a fost unul din primele aeroplane construit aproape integral din metal şi fuzelat aerodinamic. Cu excepţia pânzei aripii

şi a patinei mediane, (cross head slipper), construită din lemn – o gardă contra capotării (to prevent over nosing), era construit din tuburi de oţel acoperite cu tablă de aluminiu. Avea două locuri, unul lângă altul şi un motor rotativ "Gnôme" de 80 CP, care urma să permită atingerea unei viteze teoretice de 144 km/oră. Pentru a avea o formă cât mai aerodinamică şi pentru a activa răcirea cu aer a motorului, Vlaicu montase un inel metalic în jurul cilindrilor amplasaţi în stea. În prezent aproape toate avioanele echipate cu motoare în stea posedă acest inel metalic, cunoscut sub numele de "inel Townsend" sau "inel N.A.C.A." Deoarece acest inel a fost inventat şi aplicat pentru prima dată în lume de Aurel Vlaicu în 1913, el ar trebui să se numească "inelul Vlaicu".

6 Landing Gear

The purpose of the landing gears is to support a plane when it rests on the ground and provides its movement in take-off, landing and taxiing. Modern aircraft are equipped with in-flight retractable landing gear. (fig.6.1).

The tail-wheel landing gear and the nose wheel landing gear are the most generally used types. The former consists of the main gear and the tail wheel, with the centre of gravity of the airplane located at some distance to the rear of the main gear. With the nose-wheel landing gear the centre of gravity is forward of the main gear and to the rear of the nose wheel.

The nose-wheel landing gear is employed extensively. The main reason for the trend towards using the „tricycle" landing gear (as the nose-wheel landing gear is usually called) is that such a device ensures good stability of the aircraft during the take-off run and landing roll, and prevents it from nosing over in landing. The main wheels take up to 85% of the weight of the plane. The nose or tail wheel carries, accordingly, about 15% of the airplane weight, and it is made steerable from the foot pedals to afford ground monoevering of the plane. The main wheels may be folded either into the fuselage or the wing. Adequate room (whose dimensions depend on the number of wheels, their thickness and diameter) is required on their retraction (fig. 6.2).

The lower the pressure in the wheel tyres and, consequently, the lower the specific ground pressure, the lesser the wheels get stuck in the ground, thus enabling the plane to take off from and land on unsurfaced airfield. However, in this case the size of the wheels increase. Low-pressure tyres are particularly important when it rains and the ground is soft. Good "passability" is first of all essential for agricultural and ambulance planes, short-haul airliners, and front line airplanes.

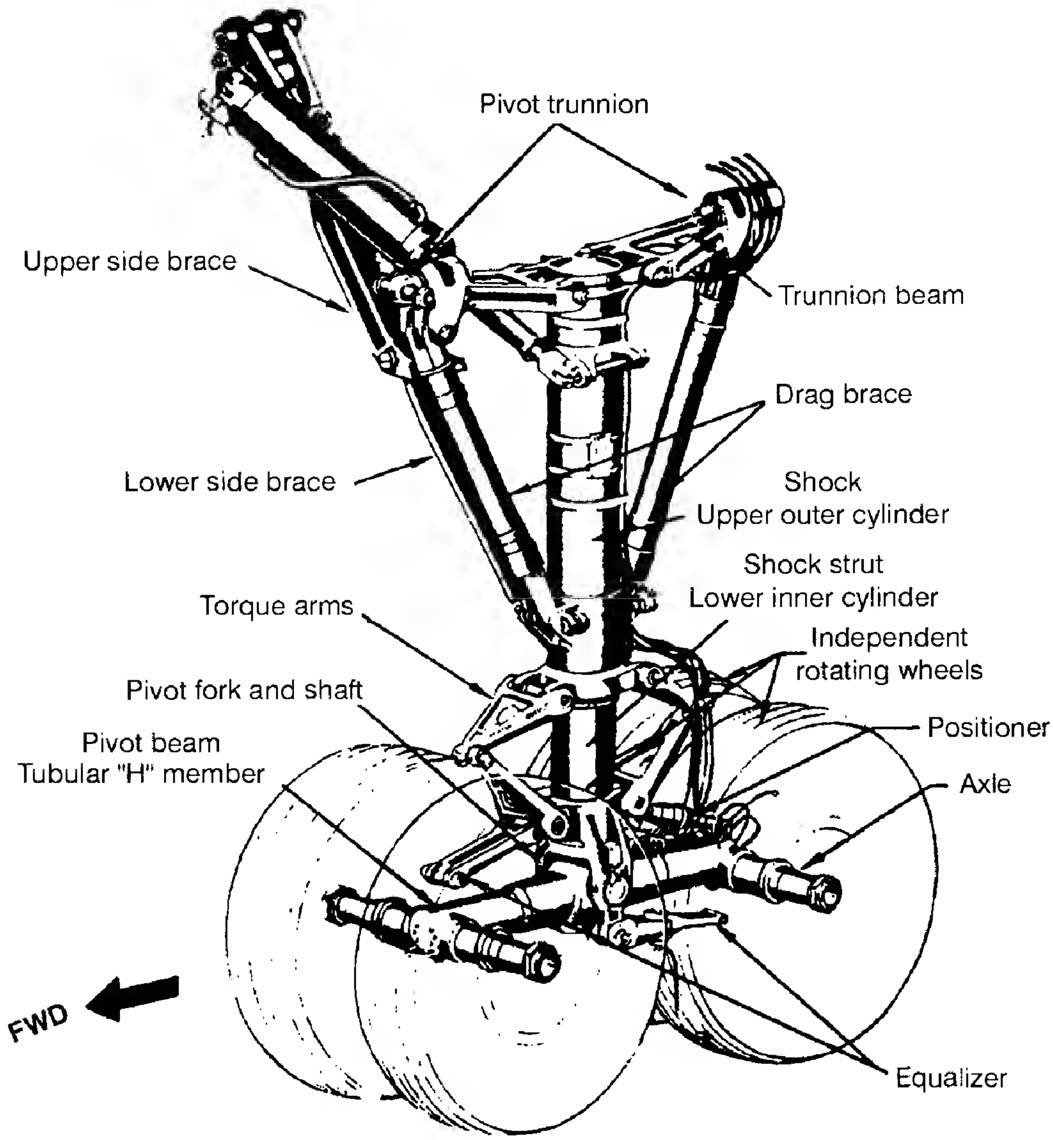


Fig. 6.1. "Bogie" truck main landing gear assembly.

Modern high-speed planes have thin wings and very densely stuffed fuselage. Wheel retraction has become quite a difficult problem for them Therefore, they are provided with high-pressure wheels and forced to operate on hard-surfaced airfields, or paved runways.

When each of two main gears is furnished with two wheels and more, they are mounted on special bogies, which ensure uniform load on the wheels when the airplane fore-and-aft tilt angle is changed and while applying the brakes. Nowadays, it is common tendency of making the landing gear height as small as possible for reasons of reducing the landing weight and making its retraction easier. The landing gear is retracted and

extended by means of the respective systems, which act automatically after being actuated by the pilot. The landing gear control systems can be hydraulically, or pneumatically or electromechanically operated. Ordinarily, there are two systems; the normal and the emergency one, which duplicate each other.

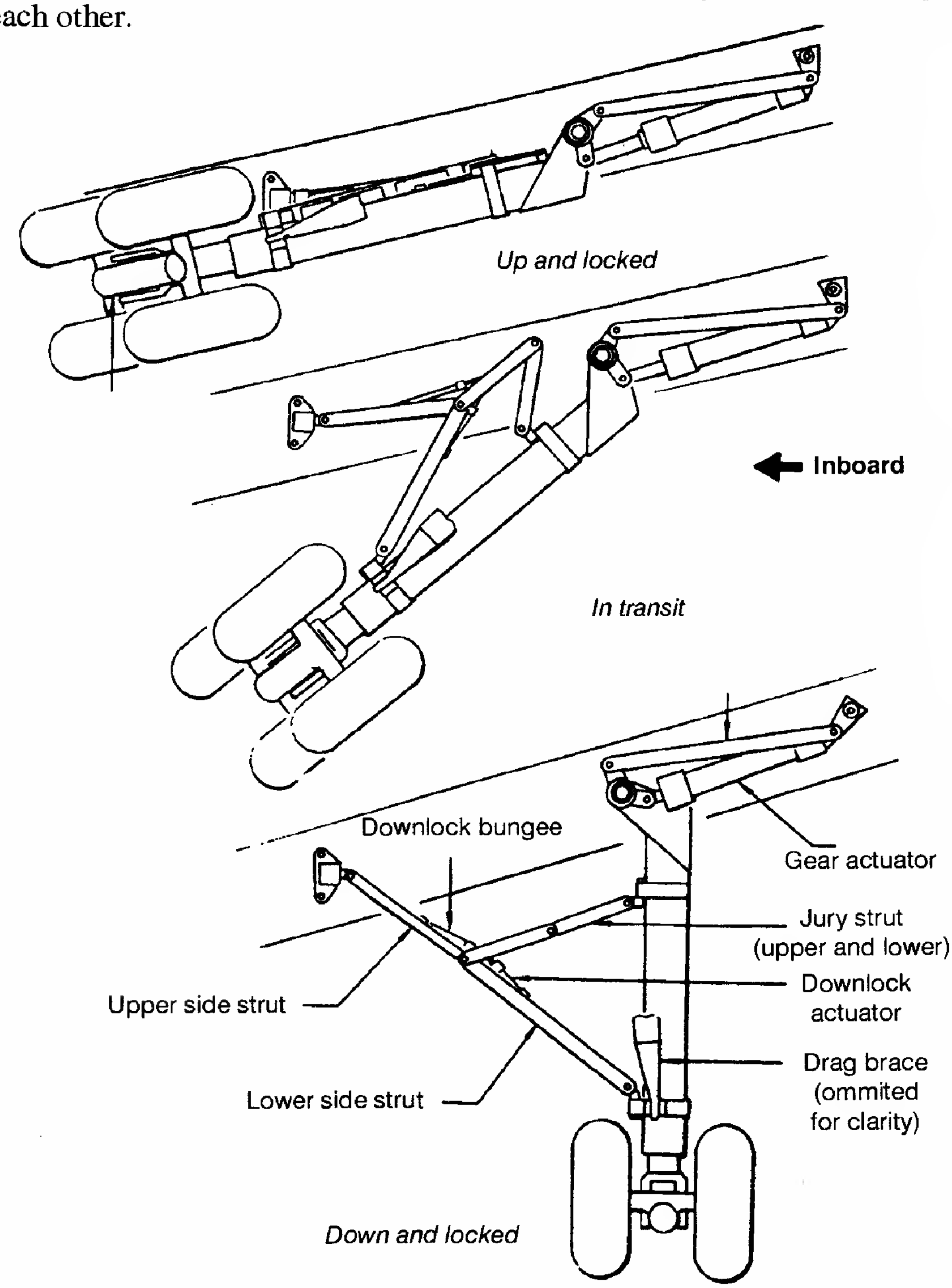


Fig. 6.2. Wing landing gear operating sequence.

The landing gear struts are provided with shock absorbers, the purpose of which is to cushion or soften the shocks to the airplane structure while taxiing from place on the airfield and to damp oscillations.The oleo-pneumatic struts are almost solely employed nowadays.

VOCABULARY

to taxi (r) = a rula pe pistă
retractable = escamotabil
rear = în spate
roll = înclinare, mişcare de ruliu, tonou, rulaj
to nose (r) = a capota
to steer (r) = a manevra, a cârmi
to fold (r) = a plia
to tilt (r) = a înclina, a apleca
strut = hobană, antretoază
to damp (r) = a amortiza
shock absorber = amortizor

NOTES TO THE TEXT

WORD STUDY

I. **Devise, device, instrument, apparatus**

a) A ***device*** is usually a clever mechanism, ***devised*** or invented to solve some particular mechanical problem.

A clutch is a **device** for engaging and disengaging gears.

b) A new method of calculation was ***devised*** (thought out) for damping vibration.

c) An ***instrument*** is usually a small manufactured object which enables us to perform some precise action or measurement.

A spectroscope is an **instrument** for measuring the spectra of rays.

d) An ***apparatus*** is a complicated mechanism or assembly of many different pieces used for some scientific experiment or test.

An Orsat **apparatus** is used to analyze the products of combustion.

II. To ensure, to insure, to assure

To ensure – to make person or think safe against risks.

In automatic flying, pilot operated pitch trim is **ensured** by the electric trim sub-system.

To insure – to secure payment of sum of money in event of loss or damage to property, life, by payment of premium.

They **insured** themselves heavily.

To assure – to make a person sure of fact

They **assured** us they would deliver the equipment in due time.

III. To work, to run, to operate, to function

This engine is designed to **work** for a long period of time.
run
operate

The machine should be tested under normal **running** conditions.
operating
working

PATTERNS

I

Noun	Adjective	Verb
depth	deep	to deepen
width	wide	to widen
thickness	thick	to thicken
thinness	thin	to thin
strength	strong	to strengthen
length	long	to lengthen
height	high	to heighten
hardness	hard	to harden
toughness	tough	to toughen

II. To prevent, to avoid, to reduce, to eliminate

The landing gear **prevents** the aircraft from nosing over in landing.

The lubrication **prevents** overheating.

Workers should **avoid** using materials wastefully.

We can	**reduce**	the **risk**	of accidents.
	prevent	**danger**	
	avoid	**possibility**	
	eliminate		

EXERCISES

I. **Comprehension**

Speak about types of landing gear using the ***key words***:

tricycle landing gear, tail-wheel landing gear, multiple wheel landing gear, extended landing gear, fixed landing gear, wheeled landing gear, ski landing gear.

II. **Translate into English**

Acest dispozitiv asigură cele mai bune condiții de funcționare. Prin acest strat protector piesa este asigurată pentru a suporta presiuni. Luna viitoare vom încheia o nouă asigurare. Uzina ne va asigura documentația necesară. I-am asigurat în ceea ce privesc intențiile noastre ferme de colaborare pentru fabricarea noului produs.

III. **Fill in** with the suitable verb:

1.Good planning ... the production costs down. 2.Cooling the metal in oil rather than water ... the risk of cracking. 3. A refrigerator ... food from altering. 4. We have to ... the steel from contact with air when we heat or cool it. The noise from the street ... him from sleeping.

IV. **Render the following sentences into English**, using pattern I

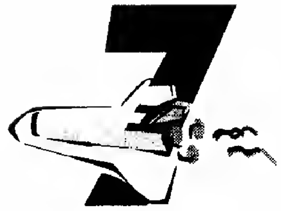
1. Este necesar ca înălțimea trenului de aterizare să fie cât de mică posibilă pentru a-i reduce greutatea şi a-i uşura escamotarea. 2. Avioanele moderne au aripi subțiri şi fuselaje foarte dense. 3. Care este grosimea barei de oțel? 4. Lățimea lonjeronului a fost dată în țoli. 5. Cum poate fi calculată rezistența acestui profil? 6. O contribuție importantă la stabilirea rigidității longitudinale a fuselajului este dată de aripa cu coardă lungă montată în partea de jos a fuselajului. 7. Metalul trebuie călit înainte de a fi turnat în forme. 8. Trebuie să-ți aprofundezi cunoştințele de aerodinamică. 9. Întărim relațiile de colaborare cu firmele de profil. 10. Duritatea acestui metal este indicată în tabelul de mai jos.

V. **Translate into Romanian**, minding the various uses of the preposition "for":

1. It is essential for you to study this problem. 2. They don't consider him fit for his job. 3. Hurry up, you'll be late for the seminar. 4. There is no tendency for the material to return to its original shape. 5. They remained here for a week. 6. We've been learning English for ten years. 7. I cannot hold it for certain that bearings are in the proper adjustment. 8. What did you do that for? 9. We were anxious for their safety. 10. He took me for my brother. 11. I asked him to stay in, for I had something to tell him. 12. Let's go for a walk, shall we?

VI. **Translate into English**:

Aeroplanele "A. Vlaicu" au fost primele maşini de zburat care au folosit trenul de aterizare cu roţi independente. Construcţia lui a fost atât de ingenioasă, încât trenul de aterizare sistem Vlaicu, din punct de vedere al principiului constructiv şi al funcţionării, a fost identic cu al avionului Fieseler "Storch", realizat în 1940 şi al avionului elveţian modern "Pilatus Porter". Aeroplanul "A. Vlaicu" a avut frâna la roata din spate, care se manevra din postul de pilotaj. Prin această noutate constructivă a timpului, Vlaicu a redus mult din lungimea rulajului pe terenul de aterizare, fără ca aeroplanul să capoteze prin frânare.



7 Aerofoils

Apart from the fuselage and the engine, the most important parts of an aircraft are the surfaces known as airfoils. These include the rudder, elevators and ailerons, whose function is to control the aircraft in flight; and the wings, which provide the lift necessary to overcome the weight of the aircraft and lift it through the air. A substantial horizontal thrust, provided by the jet or the propeller, drives the aircraft through the surrounding air, while the wing deflects downwards the mass of air flowing on to it. This produces reactive force acting in the opposite direction, which lifts the wing upwards. Without some means of horizontal propulsion, the wing can produce no lift.

Modern aircraft are so heavy that the wings must develop a very large lift force in order to sustain the aircraft.

The design of the wings is therefore very important, and various factors have to be considered. Wind tunnels reproducing flight conditions are used to examine the behaviour of air flowing over different types of wings at different speeds (fig. 7.1).

The lift produced by a wing will depend on, among other factors, the wing area, its profile, and the angle of incidence – that is, the angle at which the wing is inclined to the direction of motion.

Air flowing over the top of the aerofoil should flow smoothly and without turbulence. This laminar flow is achieved by streamlining the profile and by making the skin of the aerofoil smooth. As a result, the airflow will follow the contour of the wing, except for a narrow boundary layer of stationary air on its surface. However, above a certain angle of incidence, which varies with the type of wing, the airflow is liable to break up and become so turbulent as to destroy the low-pressure region

above the wing. This causes such a rapid loss of lift that the aircraft may stall. To counteract this, slots are sometimes fitted to the leading edge of the wing, guiding the airflow more steadily over the airfoil. Since low speeds are essential for landing, extendable flaps are also fitted to the trailing edge. These extend the effective area of the wing, and thus prevent the aircraft from stalling.

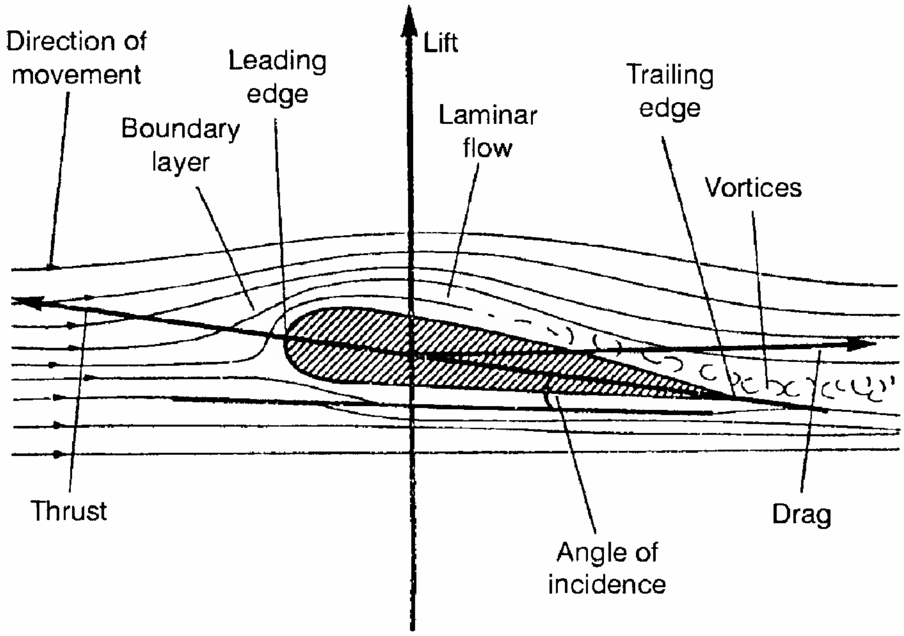


Fig. 7.1. Cross-section of aircraft wing.

The force exerted by the deflected column of air beneath the wing has a vertical component called lift, and a horizontal component called drag. Drag in its various forms represents a loss of the energy available to provide lift, but it always accompanies lift. It can never be entirely eliminated, since the wing itself offers resistance to the air through which it moves. A laminar flow over the wing, reducing drag to a minimum, is the optimum condition. But around the wing tips and the trailing edge, some turbulence is inevitable. The air, flowing through a region of higher pressure under the wing, swirls up at these edges into a region of low pressure above the wing and produces a vortex, which may be so violent as to produce vapor trails at the wing tips.

VOCABULARY

rudder = direcție
rudder bar = palonier
rudder control = comandă de direcție
elevator = profundor
thrust = forță de înaintare, tractiune
boundary layer = strat limită
to stall (r) = a pierde viteza
slot = fanta
to swirl (r) = a se roti
vortex = vârtej

NOTES TO THE TEXT

WORS STUDY

I. **Abbrevations**

i.e. (Lat. id est) = that is
viz. (Lat. vide licet) = namely
e.g. (Lat. exempli gratia) = as for example
vs. (Lat. versus) = versus

II. **Effective**

a. Having the desired effect

Heavy water is more **effective** in slowing down neutrons than graphite.

b. Real

The **effective** power of an engine can be measured by a dynamometer.

III. **Laminar, laminated, agitated, turbulent**

The airflow over the airfoil becomes **agitated** at low speeds.
turbulent

The design of the airfoil encourages a **laminar** airflow over it.
smooth

The plastic material is made of thin layers bonded together to form **laminated** plastic.

PATTERN

The active Relative (-ing)

Wind tunnels, which **reproduce** flight conditions, are used.
Wind tunnels **reproducing** flight conditions are used.

EXERCISES

I. Comprehension

Re-tell the text using: *thrust, lift, drag, laminar flow, boundary layer, vortices, angle of incidence.*

II. Word combination

Boundary layer measurement = măsurarea stratului limită

Give the Romanian for:

Vertical speed indicator, magnetic field indicator, boundary layer control, interplanetary navigation theory, supersonic wing theory, free fall velocity, free flight velocity, maximum range trajectory, aerial defense system, ballistic flight control.

III. **Change these statements** according to the pattern:

1.The aircraft, which is standing on the runway, is bound for Rome. 2. The bridge, which now spans the river, was built nearly a century ago. 3. Performances, which increase, pose more and more complex structural strength problem. 4. The points which are loading on the concrete walls and the reinforced parts of the floor allow various forces and torques to be applied. 5. Bearings which rotate at high speeds must be well lubricated. 6. The engineers who designed this motor had many problems to overcome. 7. Liquids which contain suspended solids can easily be handed by these pumps. 8. The quantity of fluid which passes a given section of the pipe can be easily measured. 9. Beryllium, which is relatively easy to machine, has been found out to have a substantial health hazard. 10. Inverted converters, which are rarely used, have been designed by a group of young engineers. 11. X-rays machines, which depend upon electricity, are used in industry to detect flaws in metal.

IV. **Translate the sentences bellow**, using: *except (for), with the exception of, without, apart from, besides, in addition to.*

1.Se ştie că toate planetele sunt nelocuite, cu excepţia pământului. 2. Toţi au venit la seminar cu excepţia lui. 3. Fără o ungere corectă lagărele se uzează foarte repede. 4. Testarea acestui tip de helicopter n-a putut fi demarată fără o investigare detaliată a bibliografiei de specialitate. 5. Elementele structurale trebuie astfel amplasate încât fuselajul să poată rezista la solicitări fără riscul de a se dezintegra. 6. Nu se poate concepe zborul avioanelor în afara unei aparaturi foarte sofisticate. 7. Grosimea aripilor la aeroplanul Coandă 1910 era constantă în lungul anvergurii dreptunghiulare cu excepţia extremităţilor . 8. În afară de faptul că aeroplanul Coandă 1910 nu avea elice, el prezenta caracteristici de profundă originalitate. 9. Avionul a fost anunţat că soseşte la ora stabilită, exceptând vremea nefavorabilă.

V. **Translate into English**, paying attention to the active Relative:

1.Forţele care acţionează pe un avion în zbor sunt portanţa, greutatea, rezistenţa la inaintare şi forţa de tracţiune. 2. Aerul care curge în jurul cabinei face un zgomot uriaş. 3. Termenul de "planetă" este folosit pentru cele mai noi corpuri cereşti care se rotesc în jurul soarelui. 4. Testele care simulează zboruri la viteze variate sunt de mare imporanţă. 5. Decelerările sunt accelerări în sens opus. 6. În ciuda perspectivelor probabile de eşec, să cercetăm informaţia existentă. 7. În capitolul precedent am analizat construcţia turboreactorului.

VI. **Translate into English**:

În 1933, mecanicul român de avion Filip Mihai a realizat o avionetă de tip "aripă zburătoare", denumit stabiloplan, din cauza stabilităţii sale în zbor. Stabiloplanul Filip Mihai tip IV avea o aripă de formă trapezoidală, cu profil gros, biconvex, pe toată lungimea anvergurii, care forma un unghi de 25° spre înapoi, constituind o suprafaţă portantă de 24,30 m^2. Pe toată lungimea bordului de fugă se aflau două aripioare ce puteau fi acţionate atât diferenţial, cât şi în acelaşi sens, prin care se comanda înclinarea aparatului în jurul axului transversal şi longitudinal. Aripa era legată de fuselaj – cabină printr-un dispozitiv original care permitea, pe o lungime de 300 mm, variaţia în sens longitudinal a poziţiei aripii faţă de fuselajul cabină. Filip Mihai a aplicat practic principiul deplasării centrului de presiune faţă de centrul de greutate, chiar şi în zbor. Realizarea practică a făcut-o prin deplasarea înainte şi înapoi a aripii. Posibilitatea de a modifica oricând centrajul de către pilot îi asigura acestei maşini de zburat o calitate aerodinamică superioară.

8 Flight Control Surfaces

The three basic flight control surfaces are the ailerons, the elevators and the rudder. The ailerons are located on the trailing edge and near the tip of the wings. When one is raised the other lowers and the airplane banks and rolls. The lowered aileron increases lift causing the wing to rise, while the raised ailerons reduce lift, causing that wing to drop. These modifications to the airfoil impose additional drag. The lowered aileron presents a relatively greater amount of drag than the raised aileron, resulting in a tendency to skid. To overcome this, a differential control mechanism causes the up-aileron to move a greater distance than the down-aileron for a given control movement.

The elevators are hinged to the horizontal stabilizer and control the airplane's movement up and down about the lateral axis. When the control stick is moved forward, the elevators lower and the airplane dives, and vice versa (fig. 8.1).

Because more force is necessary to climb than to descent, on most airplanes the maximum number of degrees the elevators can be raised is greater than the maximum number of degrees they can be lowered. Thus, the stick can be pulled back farther than it can be pushed forward. Where necessary, the pilot is aided in moving this control by a differential mechanism.

Many newer aircraft possess a different method of controlling pitch. This method combines the horizontal stabilizer and the elevators into a single surface known as the controllable horizontal tail. This surface gives easier manouevering of the aircraft at transonic speeds. The whole surface can be repositioned from the cockpit when inflight trimming is necessary.

The rudder is hinged to the vertical stabilizer (fin), and it controls the movement of the aircraft around the vertical axis (the yawing moment). The right pedal moves the rudder and the aircraft to the right. The left pedal works similary.

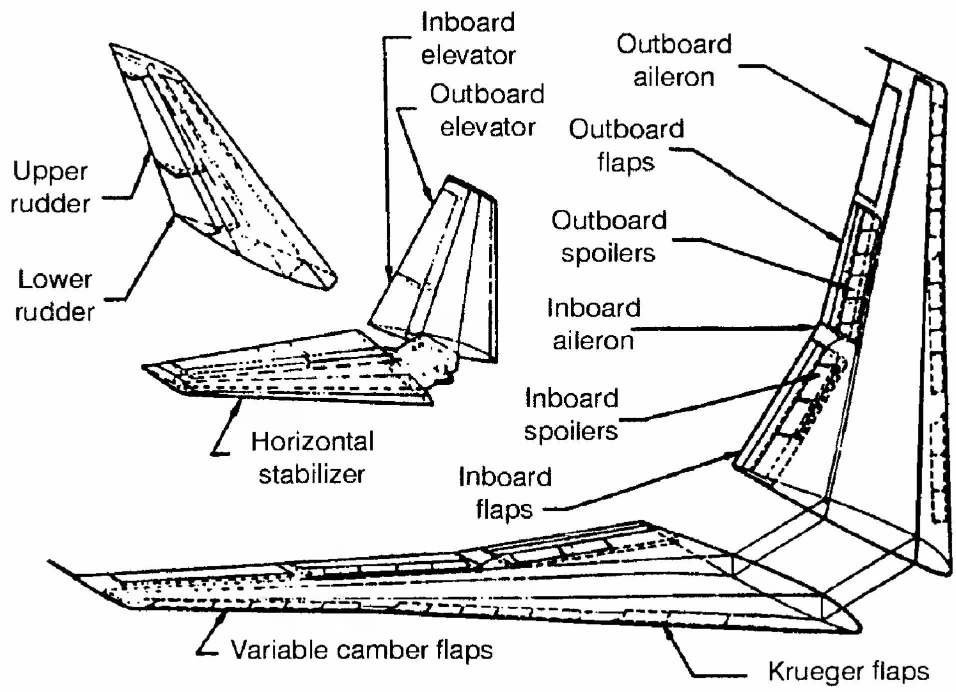


Fig. 8.1. Model 747 flight control surfaces.

The movable surfaces (rudder, elevators and ailerons) are normally of a light construction. This type of construction makes it possible to have the centre of gravity of the movable surfaces very close to the hinged line with a minimum of weight. Thanks to this centre of gravity location, vibration and flutter trouble can be avoided. Usually, with a high percentage of the movable area ahead of the hinged line, the movable surfaces present a certain amount of aerodynamic balance dependent on the speed and the movable surface size. Above 30% of the balance encounters aerodynamic difficulties due to control reversal. Whenever the cruising speed is high, hydraulically boosted controls are used to obviate excessive control stick forces.

VOCABULARY

elevator = profundor
to bank (r) = a se înclina lateral
to roll (r) = a se înclina, a face un tonou
to skid (r) = a derapa

stabilizer = stabilizator, ampenaj orizontal fix
control stick = manşă
to dive (r) = a coborî în picaj
pitch = înclinare pe orizontal, tangaj
trimming = compensare prin reacție, echilibrare
rudder = comandă de direcție
fin = ampenaj vertical fix
to boost (r) = a amplifica
to obviate (r) = a preveni, a înlătura
yaw = mişcări în jurul axei verticale

NOTES TO THE TEXT

WORD STUDY

To help, to aid, to facilitate, to assist

Safety devices	**help**	**to prevent**	accidents
	assist	**in preventing**	

The pilot is	**aided**	in moving this control by a special device.
	helped	

A good transport system **facilities** the distribution of goods.

REMEMBER

up elevator = profundor bracat în sus
down elevator = profundor bracat în jos
electric elevator = profundor acționat electric
full opposite elevator = profundor bracat complet în sens invers
horn-balanced elevator = profundor echilibrat aerodinamic
manual elevator = profundor cu comandă manual
powered boosted elevator = profundor cu amplificator / buster
unbalanced elevator = profundor necompensat
balanced aileron = eleron prevăzut cu compensator
continous aileron = eleron monobloc, dintr-o bucată
down-going aileron = eleron cu bracare în jos
drooped aileron = eleron lăsat liber în jos, eleron flaps
electric aileron = eleron acționat electric

fixed aileron = eleron fix
floating aileron = eleron plutitor
reversed aileron = eleron bracat în sens opus
slotted aileron = eleron cu fantă
wing tip aileron = eleron de capăt
tapered aileron = eleron trapezoidal
upper surface aileron = eleron cu bracare în sus

PATTERN

To enable, to allow, make + Infinitive

Note: **Enable** really means to make possible, but it is often used in the same sense as **allow** and **permit**. Let is spoken, but not written in this sense.
With **let** and **make**, the word "to" is not used before the infinitive

Helicopters **enable** passengers to land in the city centers.
Microscopes **enable** scientists to examine very small objects.
Expansion joints **permit** the pipe to expand or contract.
allow
Weakness in the metal **made** it fracture.
caused the metal to fracture.

EXERCISES

I. Comprehension

Answer the questions:
1. Where are the ailerons located?
2. What do the elevators control?
3. What does the rudder control?

II. Give the Romanian equivalents for:

adjustable stabilizer, horizontal stabilizer, mechanical stabilizer, movable stabilizer, vertical stabilizer.

III. **Fill in** the blanks with the appropriate words (*to rise, to raise, to arise*):

1. In a few hours the fog will ..... 2. Their wages will be .... 12% next month. 3. The sun .... at 4 that morning. 4. As it has been mentioned, he .... by merit

only. 5. The image of the new plant .... in my mind. 6. The level of the liquid ... continuously. 7. The taxes ...... these years. 8. Unfortunately everything .... from a misunderstanding. 9. Don't wait for the ... of the tide, it will be too late. 10. Many difficulties ..... when they started working together.

IV. **Give the plural forms** of:

axis, basis, radius, nucleus, thesis, formula, minimum, antenna, hypothesis, lacuna, vacuum, medium.

V. **Fill in the blanks** with the prepositions required by the adjectives:

1.He is **good** .... mathematics. 2. I'm **busy** ... my work. 3. They are **certain** .... the result. 4. This student is **keen** ... physics. 5. How **kind** ... you to come. 6. They are **capable** ... solving the problem. 7. The machine is much too **slow** .... running. 8. You are **clear** ... any fault. 9. We have run **short** .... gas. 10. The subject is **void** ... interest.

VI. **Complete the sentences bellow** according to the given pattern:

1.The rise in temperature ... the mercury ... rise up the tube. 2. The presence of oxygen ... crash. 4. The sharp rise in temperature ... the engine overheat. 5. The use of a pressure gauge .... the engineer .... read the boiler pressure. 6. Rapid cooling ... unequal contractions .... occur in the metal. 7. The increase in export... the country .... import more raw materials. 8. The presence of non-metallic constituents in iron ... it ... behave in various ways. 9. Stringers .... the skin alongside the spar flanges ... accept a bending moment. 10. The differential gear ... the two rear wheels ... turn at different speeds.

VII. **Translate into English**:

Avioanele fără coadă nu au nici ampenaj orizontal fix, nici profundoare. Funcţia acestora este preluată de eleroane, care poartă numele de elevon. Elevoanele asigură astfel nu numai controlul lateral şi longitudinal al avionului, ci şi echilibrarea. Ca dimensiune, elevoanele sunt mai mari ca eleroanele, şi se pot mişca în sus sau în jos, simultan, la fel cu profundorul. Elevoanele sunt porţiuni mobile ale aripii, acţionate de piloţi. Ele ocupă 20–25% din coada aripii (ca lăţime), socotind de la bordul de fugă şi extinzându-se de-alungul anvergurii aripii până la vârfuri. Suprafaţa totală a ambelor elevoane constituie 8–10% din suprafaţa portantă a aripii. Ele se mişcă în direcţie opusă, unul în sus, iar altul în jos.

9 Aeroplane Control

By the airplane control one usually implies the devices and systems intended to deflect the aeroplane controls (or flight control surfaces) with a view to changing the aeroplane flight attitude, e.g., the pitch control (i.e., the fore-and aft inclination of the aeroplane towards the horizon), roll (or bank control, and yaw (or turn) control of the aeroplane.

The aeroplane control system incorporates the pilot's control stick (or control wheel) to control the elevator and ailerons, the foot pedals to control the rudder, the control knobs, handgrips, and handles to control various units and systems of the plane (including the control of the power plants and fuel systems), and the control linkage consisting of pushpull rods, cables and levers.

To change the airplane spatial attitude, it is merely necessary to turn it in one or another plane relative to the centre of gravity. To do this a control force is required, which is at some distance from the centre of gravitation, and occurs when the aeroplane control surfaces are moved. Raising and lowering the elevator control surfaces (or the entire tail plane) change the pitch attitude, movement of the ailerons produces the roll attitude, and turning the rudder control surface to the right or to the left varies the yaw attitude, i.e., the angle between the plane of symmetry of the plane and the direction of its motion (fig. 9.1).

When forward pressure is applied to the pilot's control stick (or control wheel), the elevators move downward. As a result, the horizontal tail surface produce the control force directed upward, thus causing a nose-down pitching moment (the plane nose lowers). Conversely, when backpressure is applied to the stick (or control wheel), the elevators move upwards to initiate a nose-up pitching moment (the plane nose rises).

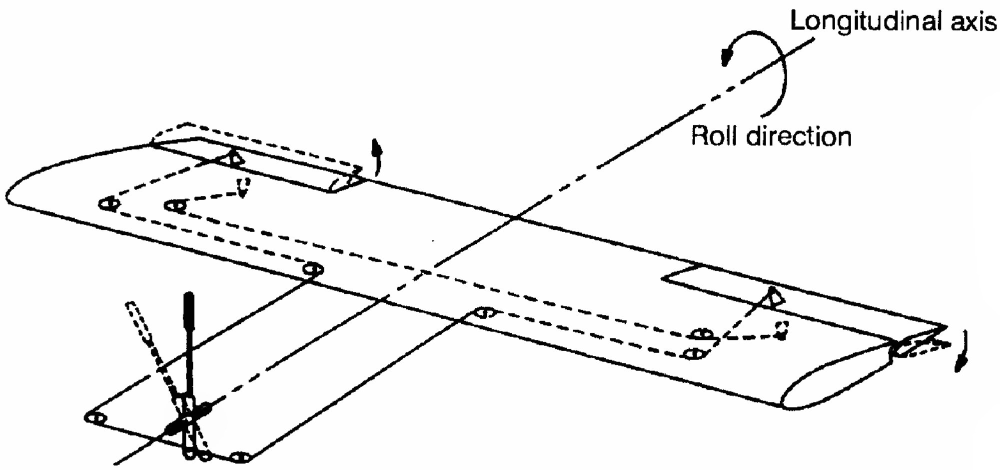


Fig. 9.1.

When the pilot's control stick is pressed to the right, the left aileron goes down and the right aileron goes up. Thus there originates a pair of control forces: one directed upwards on the port wing and the other directed downward on the starboard wing. The airplane begins to bank (or rotate about its axis of symmetry) towards the right half wing. The picture is reversed when the control stick is pressed to the left.

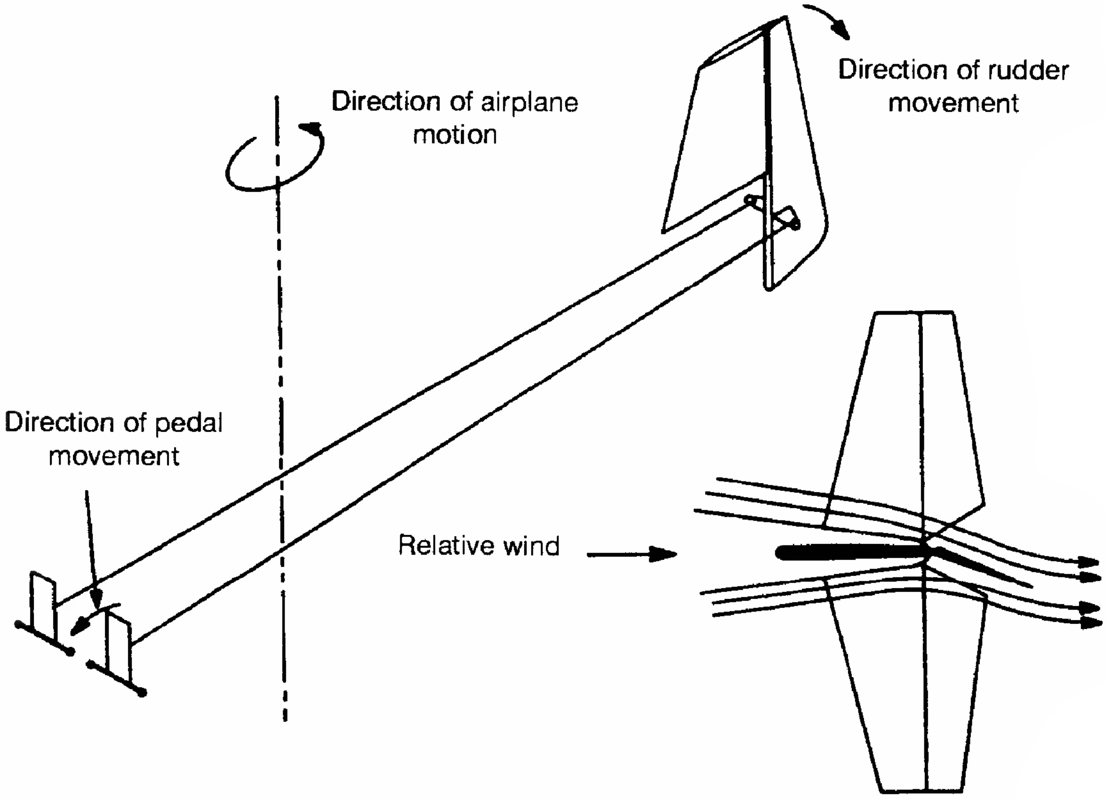


Fig. 9.2.

The control stick is designed so as to enable the pilot not only to operate it with one hand but also to perform some other functions, such as to actuate the wheel brakes, press the firing buttons or squeeze the triggers of the plane weapon, and so on. The second hand is set at liberty for controlling the engine, actuating the landing gear and flaps and for executing a variety of other operations.

Principally, the rudder pedals are designed in much the same manner in all the aeroplanes. The pilot operates the rudder pedals with his feet. Pressing the right rudder pedal swings the plane to the right. Pressure on the left pedal swings the rudder to the left. Each pedal is also provided with a device linked to the wheel brakes and the nose wheel (or tail wheel) steering system (fig. 9.2).

VOCABULARY

pitch = tangaj, înclinare pe orizontală
roll = tonou, ruliu
yaw = mişcare în jurul axei verticale a avionului
control stick = manşa
knob = buton
push pull rod = tija de comandă
linkage = mecanism cu pârghii, transmisie prin sistem de pârghii şi tije
nose-down pitch = picaj
nose-up = cabraj
to steer (r) = a cârmi, a conduce, a dirija
port wing = aripă stânga
starboard wing = aripă dreapta
to deflect (r) = a braca, a deforma, a abate
deflection = cursă, abatere

NOTES TO THE TEXT

WORD STUDY

I. **Deflection**

1. The departure of an indicator from the zero reading on the scale of an instrument.

   A **deflection** was noted on the gauge.

2. To bend down
   The thin rod was **deflected** during the test.
3. To turn from a straight or fixed course.
   The pilot **deflects** the airplane control.

II. **To augment, to boost**

The jet thrust may be **augmented** by after-burning in the jet pipe
boosted

III. **Actuator** is a mechanism for moving or control something indirectly instead of by hand.

PATTERNS

I. *Movements*

1. **To actuate, to operate, to put into mechanical action**

The pilot **actuates the trim.**

A flexible belt	**drives**	the motor.
	makes it **move**	
	turn	
	work	

2. The control stick **moves**	forwards.	A(n)	forward	movement
travels	backwards		backward	of the
slides	up		upward	piston
runs	down		downward	

The piston	**reciprocates**	A	**reciprocating**	movement
	or **moves**			engine
The wheels	**rotate**	A	**rotational**	movement
	turn		**rotary**	
	revolve			
The steam	**circulates**	A	**circulating**	movement.

II. *Purpose*

The control stick is designed **so as to enable** the pilot to operate it with one hand.

The control stick is designed **to** / **so as to** / **in order to** enable
for the purpose of / **with the object of** / **with the aim of** / **with a view to** enabling

the pilot to operate it with one hand.

EXERCISES

I. **Comprehension**

Complete the sentences below:

1. The airplane contol system incorporates .... 2. To change the airplane spatial attitude, it is necessary to ... 3. The pitch attitude is changed by .... 4. Movement of ailerons produce ...5.The yaw attitude is varied by... 6. A nose down pitching movement is caused..... 7. A nose-up pitching movement appears .....

II. **Give the English** equivalents for:

mişcare înainte şi înapoi
mişcare de du-te vino
mişcare de la stânga la dreapta
mişcare de sus în jos
mişcare de jos în sus
mişcare de rotație
mişcare reciprocă

III. **Make sentences** with the following verbs:

To cut in, to cut off, to cut out, to nose over, to nose up, to roll of, to run in, to run up, to slow down, to slow up, to turn about, to turn around.

IV. **Give the English** equivalents:

Bracarea eleronului	cursa manşei
abaterea automată	cursa palonierului
bracarea profundorului	bracarea profundorului în sus
abatere maximă	abaterea țevii de eşapament
abatere completă	abaterea jetului de evacuare
deflecția curentului de aer	abaterea comandată de pilot

V. **Practice Pattern II** in translating the examples:

1. Noi tehnologii de fabricaţie au fost folosite în scopul de a îmbunătăţi produsele. 2. Computerele sunt folosite aproape în toate domeniile de activitate în vederea sporirii productivităţii muncii. 3. Pentru a schimba poziţia avionului sunt necesare diverse manevre ale manşei. 4. Pentru a rezista la solicitări mari, materiale speciale sunt folosite la învelişul avionului. 5. Scopul testului este de a calcula creşterea totală a temperaturii. 6. Amplificatori de forţă (acceleratori booster) sunt folosiţi pentru a spori forţa necesară acţionării diverselor suprafeţe de comandă. 7. Pentru a rezista la temperaturi de peste 250°C din lagărele şi mecanismele turboreactoarelor, o nouă categorie de lubrifianţi a fost folosită. 8. Pentru a preveni efectele încălzirilor aerodinamice, ce cresc exponenţial cu viteza de zbor, se impune dincolo de Mach 2 utilizarea aliajelor de titan şi a oţelurilor înalt aliate în locul aluminiului obişnuit. 9. În vederea soluţionării ecuaţiilor ce guvernează lubrificaţia de gaze şi cea în regim turbulent, oamenii de ştiinţă români au avut o contribuţie hotărâtoare. 10. Acoperiri ceramice şi metaloceramice sunt folosite cu succes pentru a spori rezistenţa materialelor la solicitările complexe mecano-termice.

VI. **Given an oral account** of the following:

Attainement of high subsonic and supersonic speeds in aviation have brought about two new circumstances. First, the amount of the required control force increases as the flight speed grows up. The forces needed to deflect the flight control surfaces have become such that the man's physical strength is found to be not more sufficient for this purpose. Designers have created "boosters" – amplifiers. In boost (or power assisted) control, the pilot (while moving his control stick, control wheel, or rudder pedals) displaces not only the flight control surfaces properly but merely the booster slide valves which communicate passages in the booster housing. Special fluid is under high pressure delivered through these passages from the respective containers to either chamber of the actuation cylinder, whose rod is linked to a given control surface. Thus, the pilot's effort is required only for moving the slide valves, whereas the force needed to deflect the flight control surface is produced by the actuation cylinder.

VII. **Translate into English**:

În general, mişcările avionului se referă la mişcările faţă de axele longitudinale, laterale şi verticale. Tangajul în jurul axei sale este comandat de profundor. Ruliul în jurul axei longitudinale şi mişcările în jurul axei verticale sunt comandate simultan de eleroane şi direcţie.

10 Automatic Flight Control System and Aircraft System

In the navigation system of a supersonic transport, the main functions are carried out by inertial platforms coupled to digital computers. A continuous flow of accurate data is supplied on the aircraft position, track deviation and estimated time of arrival.

The flight operations of a supersonic transport demand an automatic flight system, consisting of the following sub-systems, for example: autopilot and flight director, three axis autostabilisation, autothrottle and electric trim. Using the same computing and mode selection facilities, the autopilot and flight director form an integrated system. Climb, cruise and landing are controlled automatically by the autopilot. In all these modes, a fail-safe operation is provided by monitoring techniques. The autopilot demands can be monitored by the pilot (man) through the flight director commands. The autopilot and flight director incorporate the moving map display, which continuously shows the position of the airplane relative to the terrain below.

Operating directly into the elevons and rudder surfaces, the three-axis autostabilisation sub-system is designed to improve the handling of the aircraft.

Thrust is controlled according to indicated air speed or Mach number by the auto throttle sub-system operating the pilot's throttle levers.

In automatic flying, pilot operated pitch trim is ensured by the electric trim sub-system.

The above sub-systems are integrated with the aircraft systems. The hydraulic services are powered by two main separate systems; there is a separate system as standby for the main systems. The flying control surfaces, artificial feel units, landing gear, wheel brakes, nose wheel steering, the moving surface of the engine air intakes, and the fuel transfer pump or the rear trim tank, as well as other devices are hydraulically actuated. High-speed response combined with low weight is given by the system operating pressure of 4,000 psi (fig. 10.1).

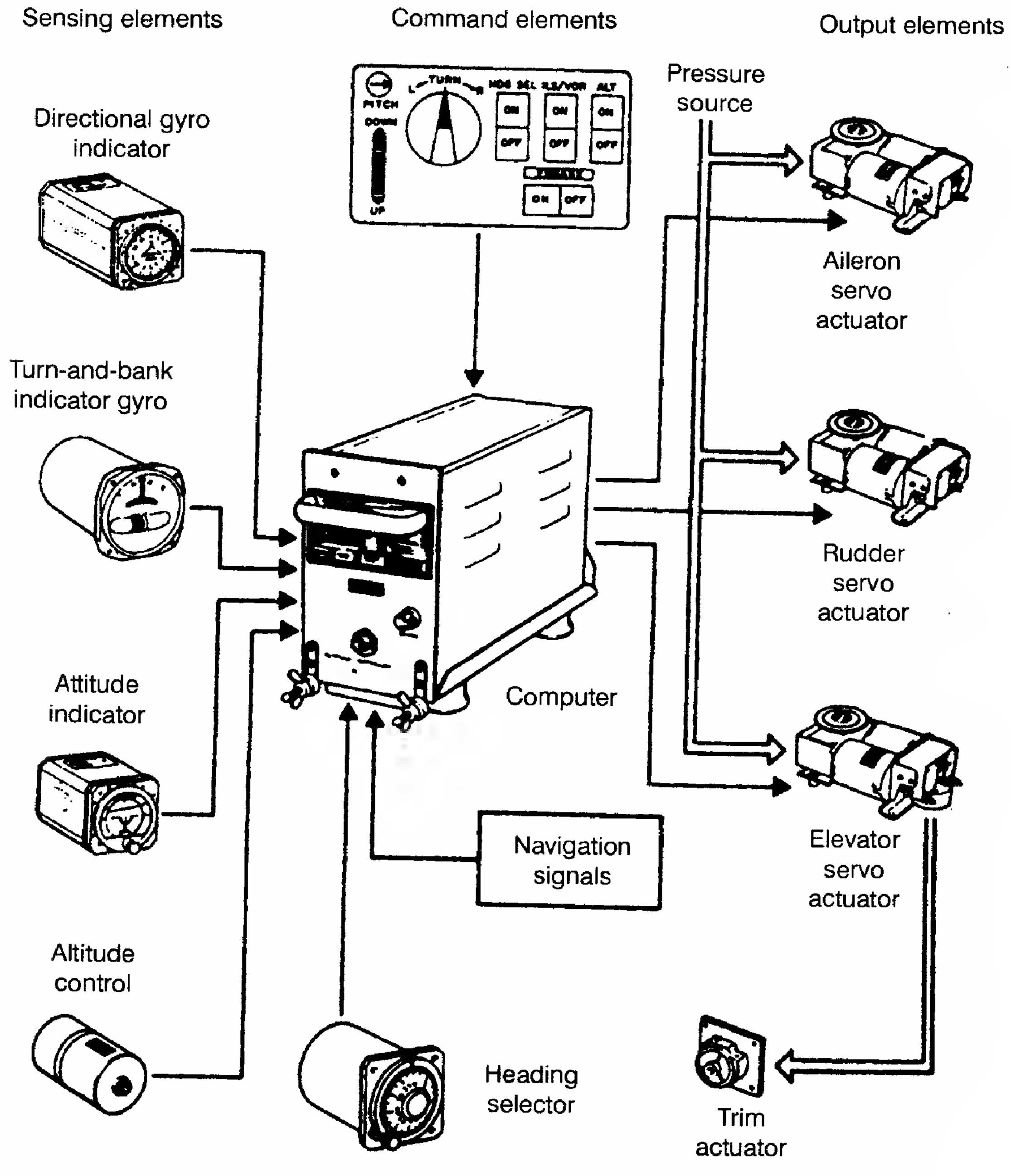


Fig. 10.1. Typical autopilot system components.

Note how the control of the movable surfaces is effected. All control surfaces are independently power operated and controlled through movement initiated from dual control column and rudder pedals. Mechanical movements are converted to electrical signals, which actuate servo-valves controlling hydraulic jacks in the power control units. Autopilot is effected by signals fed into the normal control circuit through

the hydraulic booster jacks. An independent stand-by mechanical system with hydraulic servo-assistance assumes control in the event of complete electrical failure.

VOCABULARY

flow = flux
track = rută, cale
ETA - Estimated Time of Arrival = ora estimată de sosire
flight director = dispozitiv de ghidare în zbor
throttle = manetă de gaze
climb = urcare
to cruise(r) = a merge cu viteză de croazieră
fail safe operation = funcționare cu coeficient superior de siguranță
to monitor (r) = a controla
to trim (r) = a regla, a echilibra
artificial feel = mecanism/automat pentru crearea eforturilor în comenzi-/reproducerea artificială a eforturilor în comenzi
display = afişaj

NOTES TO THE TEXT

WORD STUDY

To affect, to effect

To affect – to produce an effect upon
The temperature of the conductor **affects** its resistance to current.

To effect – to bring about, to produce, to make, to accomplish
Autopilot is **effected** by signals.

PATTERN

Noun+ Noun

The normal way of describing an object in front of the noun, and sometimes two or three:

fail safe operation
flight director commands

EXERCISES

I. **Comprehension**

Complete these sentences:

In the navigation system of a supersonic transport, the main functions are carried out .... A continuous flow of accurate data ... The automatic flight system consists of the following subsystems: .... The autopilot and flight director form.... Climb, cruise and landing are controlled .... In automatic flying, pilot operated pitch trim .... There are hydraulically actuated ...

II. **Translate into Romanian**:

rudder control surfaces
three axis autostabilisation subsystem
artificial feel units
nose wheel steering
fuel transfer pumps
sea level temperature
sea level pressure
moon exploration vehicle
motor test vehicle
aircraft escape system
antenna rotation switch
target identification system
shaft rotation speed
missile range measurement

III. **Give corresponding nouns** to the verbs:

to assume, to recognize, to solve, to compare, to predict, to drive, to effect, to deflect, to transmit, to convert, to displace.

IV. **Change the following sentences** using modal verbs expressing the ideas indicated in brackets:

1.This device had been invented long ago (possibility). 2. Don't worry about the machine being overworked (advisability). 3. Perhaps he arrives tomorrow (supposition). 4. They are at station at 10 (necessity). 5. I want you to succed (wish). 6. It is prohibited to smoke within this area (request). 7. Take a seat (polite request). 8. The autopilot demands are monitored by the pilot through the flight director commands (obligation). 9. All bases on the planets have visual observation facilities (necessity). 10. Exploration of the planets includes a search for life in any form (obligation).

V. Change the modal verbs in the sentences below into Present and Past Conditional according to the model:

This phenomenon **can occur** under certain conditions.

may
could occur
might
could have occurred
might have

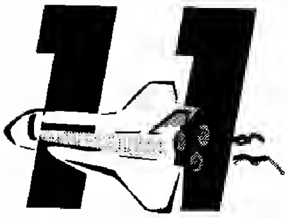
1. The main wheels may be folded either into the fuselage or the wing. 2. The cabin window glass panels may become fogged or frozen. 3. Wings can be broken up by gusts. 4. Down-gusts may break the tail surfaces or throw the aircraft against the ground. 5. The tail length can be made a conventional 3 mean chords from c/4 to elevator hinge. 6. Wings may be classified as long wings, high-wing, mid-wing, delta wing, swept wing, swing wing, variable geometry wing. 7. The horizontal tail incidence may be either fixed or variable in flight. 8. The minimum control speed, at which control can be maintained for a multi-engine aircraft with an inoperative engine, must be approximately equal to 1.3 times the stalling speed. 9. Adequate control of the engine can be provided by jet vanes. 10. Man can live on liquid food for weeks without losing his weight. 11. The velocity of stars can be determined by examining the spectrogram of the light which comes from it. 12. Reliability of the construction can be improved by using additional elements.

VI. **Restatement drill**:

Model : *A thermostat is said to have intelligence.*
It is said that the thermostat has intelligence.

1.This machine can be said to have an open-loop system. 2. He was expected to check air temperature regularly. 3. Pneumatic and hydraulics were proved to be flexible and versatile means of power and control. 4. Memories were reported to have been impressed magnetically. 5. Electricity was thought to be an invisible fluid. 6. The space between the Sun and Earth was thought to be empty until quite recently. 7. The first Earth's satellites were expected to stay on their orbits for a month or two.

8. The sun is known to have a 11-year cycle of activity. 9. The rocket may be said to work on the reaction principle. 10. Astronautics is considered to be the science and technology of the design and operation of space vehicles. 11. The speed of the aircraft at the time of explosion is estimated to have been at 300 knots. 12. No other forces are assumed to act on the fuel tank bottom.



11 Jet Engine

Jet engine with which most modern high-speed aircraft are equipped develop thrust on the same principle as the propellers conventional aero engines. In both, the propulsive force is derived from the reaction produced by a stream of air driven rearwards at high velocity. However, in jet propulsion the air is directed rearwards in a jet from the engine itself. The earliest forms of jet propulsion were incapable of functioning at rest, in view of the absence of any means of air-compression.

But the introduction of the turbo jet overcomes this problem, since the turbine developed sufficient power to drive a compressor. Air enters the engine through a divergent inlet duct, in which its pressure is raised to some extent. It then passes to a compressor, where it is compressed, and from which it is delivered to the combustion chambers. These are arranged radially round the axis of the turbine, into which the products of combustion pass on leaving the combustion chambers. A proportion of the power developed by these gases is utilized by the turbine to drive air-compressor, and the residual energy provides the thrust whereby the aircraft is propelled. Due to the expansion of the exhaust gases in the jet-pipe behind the turbine, their exit velocity is very high (fig. 11.1).

In each of the combustion chambers, there is a perforated flame-tube into which kerosene is sprayed and ignited. Owing to the need to limit temperatures in the combustion chambers, a large volume of excess air is required (fig. 11.2).

The air /fuel ratio necessary to reduce combustion temperatures to an acceptable level is about 60:1. However with this ratio of fuel to air, the mixture would be difficult to ignite. Therefore only a small proportion of the compressed air is fed into flame-tube where it is ignited in a ratio of about 15:1. The remainder enters the flame-tube further down, or mixes with the products of combustion as they leave the tube. By virtue of dilution of the hot gases with cooler air, the temperature at which they reach the turbine is reduced to about 850°C.

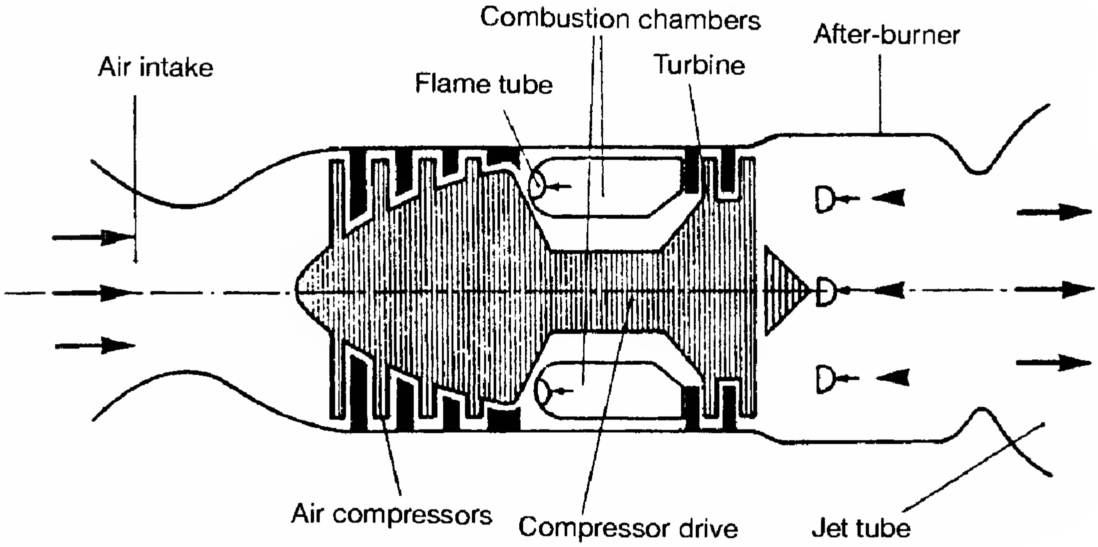


Fig.11.1 Cross-section of turbojet engine with after-burner.

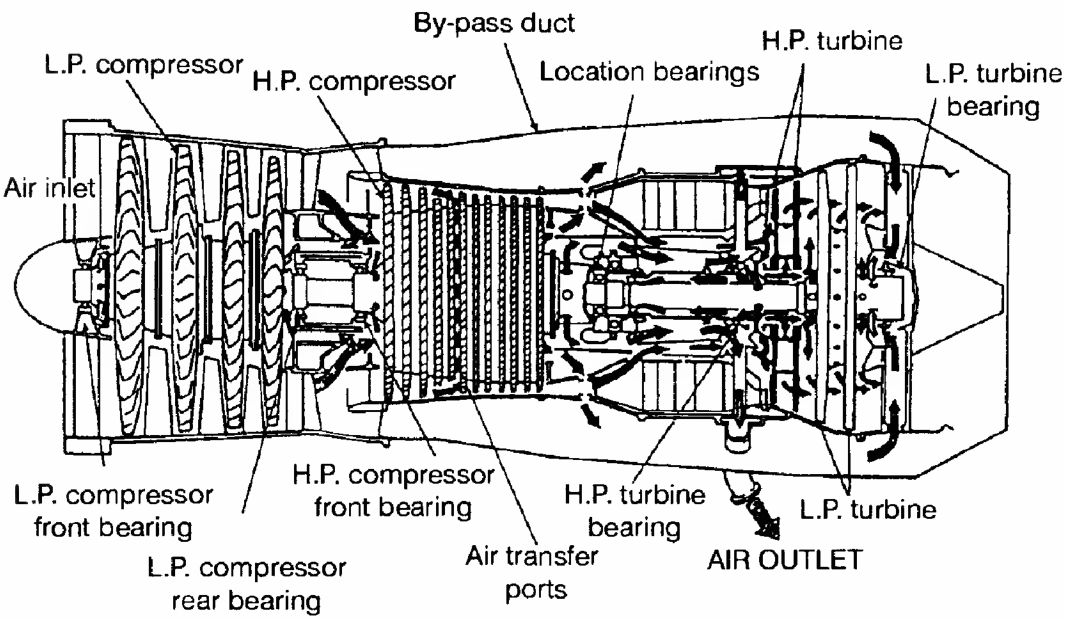


Fig.11.2. Components of a jet engine.

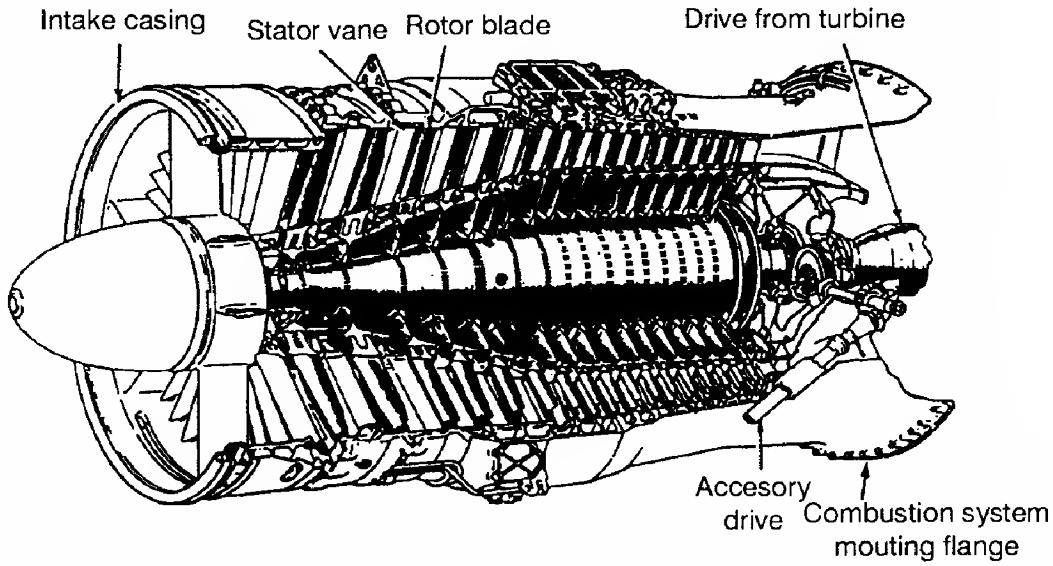


Fig.11.3. Single spool compressor.

On entering the turbine, the gases pass through nozzles, by means of which they are directed through a ring of blades. These blades, the shape of which is determined by the need to reduce the torque to a minimum, rotate at high speed. Because of the tendency of fast-running blades to creep and change their shape, a special high-nickel alloy is used for them. After passing through the turbine, the gas expands down the jet-tube and is ejected into the atmosphere. Owing to the high proportion of unburnt oxygen in this efflux, after-burners are often provided in the jet-pipe whereby the hot gases are again ignited. This increases their velocity, and provides extra thrust for take-off (fig. 11.3).

VOCABULARY

jet pulse = motor pulso-reactiv
duct = țeavă, conductă
after burner = cameră de postcombustie
creep = fluaj
torque = cuplu

NOTES TO THE TEXT

WORD STUDY

I. Engine, motor, machine, tool

An **engine** – steam engine turbine aero-engine A **motor** – a small electric motor	These produce power
A **tool** A **machine**	use power

II. To control, to regulate

The movement of the valve **is regulated** by a servomotor.
The temperature in the vessel **can be controlled** within strict limits.

III. To govern, to determine, to fix

The type of engine adopted	is	**determined** by the use of which is put.
		decided
The amount of excess air		**governed** by the combustion temperatures
		fixed required.

VI. Residue, remainder

What remains The remainder	of the heat from the exhaust gear is used to heat the incoming air
The residue The residual The remaining	heat of the gases is used to heat the incoming air

V. To dilute, to diffuse, to disperse

The hot gases have to be **diluted**_(weakened) by the addition of cool air.
The air in the pump is **diffused** in a divergent cone (spread out).
The buildings are **dispersed** (scattered) over a wide area.

VI. **Remember**

wherein – in what, in which
whereupon – after which, then
whereby – by that, by which
therein – in that place
thereupon – then, as a result of
thereby – by that means

PATTERNS

I. **Prepositions with "which"**

In technical writing the preposition is usually placed before (which) or (whom) and not at the end of the sentence, as it normally is in speaking.

Jet engine, with which most modern aircraft are equipped...

Notice: The air passes through a compressor where (in which) it is compressed.
After-burners are provided, whereby (by means of which) the gases are again ignited.

II. **Ratio and proportion**

a) There is one professor to every 10 students. They are in a ratio of 1 to 10.

b) There are 15 parts of air to every part of fuel. There are in a ratio of 15 to 1.
The air/fuel ratio is 15:1.
The efficiency of a cycle process is the ratio of the work done to the heat received.

EXERCISES

I. **Comprehension**

1. Speak about the working principle of a jet engine.
2. Where are the combustion chambers located?
3. What is the air/fuel ratio?
4. Why are after-burners provided in the jet pipe?

II. **Put the correct word or words** in the sentences:

1. The exhaust steam is passed to a condenser ... it is condensed. 2. 10 degrees is the limit ... the nozzle can control the steam flow. 3. There is an expansion period ... air burning of the fuel may take place. 4. The material ... the apparatus is made is good conductor of heat. 5. This depends on the purpose ... the exhaust steam used. 6. The rate of wear of the bearing depends on the efficiency .... it is lubricated. 7 Radial flow turbines differ in the manner ... the steam flow is arranged. 8. There is a combustion chamber in the top ... is fitted an inlet valve. 9. This fuel is a mixture of gases, the chemical combination .... is known. 10. The hot water is taken to a heat exchanger ... steam is generated.

III. **Join these sentences** using ***a preposition + relative***:

1.The air is passed to a compressor. Here it is compressed. 2.The earliest turbine consisted of a sphere. Steam was passed into the sphere. 3. There is a perforated flame tube. Kerosene is sprayed into it. 4. The light passes through a prism. The prism disperses the light. 5. Iron is converted into steel by various processes. All of these processes involve heating it to very high temperature. 6. The fuel is contained into metal can. The purpose of this can is to prevent reactions between the fuel and the coolant. 7. The power station is in the north of the country. Plutonium is produced in this power station.

IV. **Translate the following sentences** by using:

proportional to, inversely proportional, in a proportion of, in relation to, for.

Tensiunile tangenţiale produse la răsucirea unei bare de secţiune circulară sunt direct proporţionale cu momentul de răsucire şi invers proporţionale cu modulul de rezistenţă polar. Capacitatea de evaporare este mică faţă de dimensiunea cazanului. Alimentarea cu combustibil este sporită proporţional, deoarece este nevoie de mai multă energie. Raportul de aer/combustibil este de 15:1.

V. a) **Link these statements** by using : in view of the fact that,
on account of the fact that,
owing to the fact that,
seeing that,
by virtue of,
owing to,
due to

1. Exhaust gases still posses a great deal of heat. They can be used to heat the incoming air to the boiler. 2, The carburetor may become choked with dirt. An air filter is fitted. 3. The engine load increases. The depression in the Venturi tube grows. 4.Fuel is consumed. Its level drops in the float chamber. 5. This type of engine is very widely used. It has a much greater efficiency. 6. The coolant is heated to 75°C. The liquid in the thermostat starts evaporating. 7. These gases expand in the cylinder. The piston goes down. 8. The earliest form of jet propulsion was incapable of functioning at rest. They had no means of air compression. 9. High thrust at low airspeed is not a turbojet characteristic. To be at their best, they require very long runways for take off.

b) Re-phrase the above sentences by using:

The reason why .... is that
This explains why ...
This accounts for the fact that ...

VI. **Translate into English**:

Motorul aero reactiv inventat şi realizat prima dată de Henri Coandă, denumit de el "turbopropulsor", era, conform clasificării actuale a acestor motoare, un motoreactor. Se compunea din următoarele: un motor cu piston cu patru cilindri, răcit cu apă, de 50 CP, la 100 rot/min, care antrena, prin arbore multiplicatorul de rotații. Acesta rotea compresorul, imprimându-i o rotație de 4000 rot/min. În fața compresorului se găsea obturatorul, care acționat de pilot, regla intrarea aerului la compresor. Acesta refula aerul în camerele de ardere de secțiune inelară, amplasate lateral, de o parte şi alta a fuselajului, în care se găseau țevile prin care se evacuau gazele de ardere. În aceste țevi se pulveriza combustibilul, prin mai multe injectoare. Combustibilul ardea în contact cu gazele de ardere ale motorului cu piston şi, în prezența aerului livrat de compresor, gazele produse prin această ardere ieşeau cu viteză, producând astfel forța de reacție necesară propulsiei aeroplanului.

12 Gas Turbine Engine

The gas turbine engine is essentially a heat engine using air as a working fluid to provide thrust (fig. 12.1). To achieve this, the air is increased. To obtain this increase, the pressure energy is first of all increased, followed by the addition of heat energy, before final conversion back to kinetic energy in the form of a high velocity jet efflux.

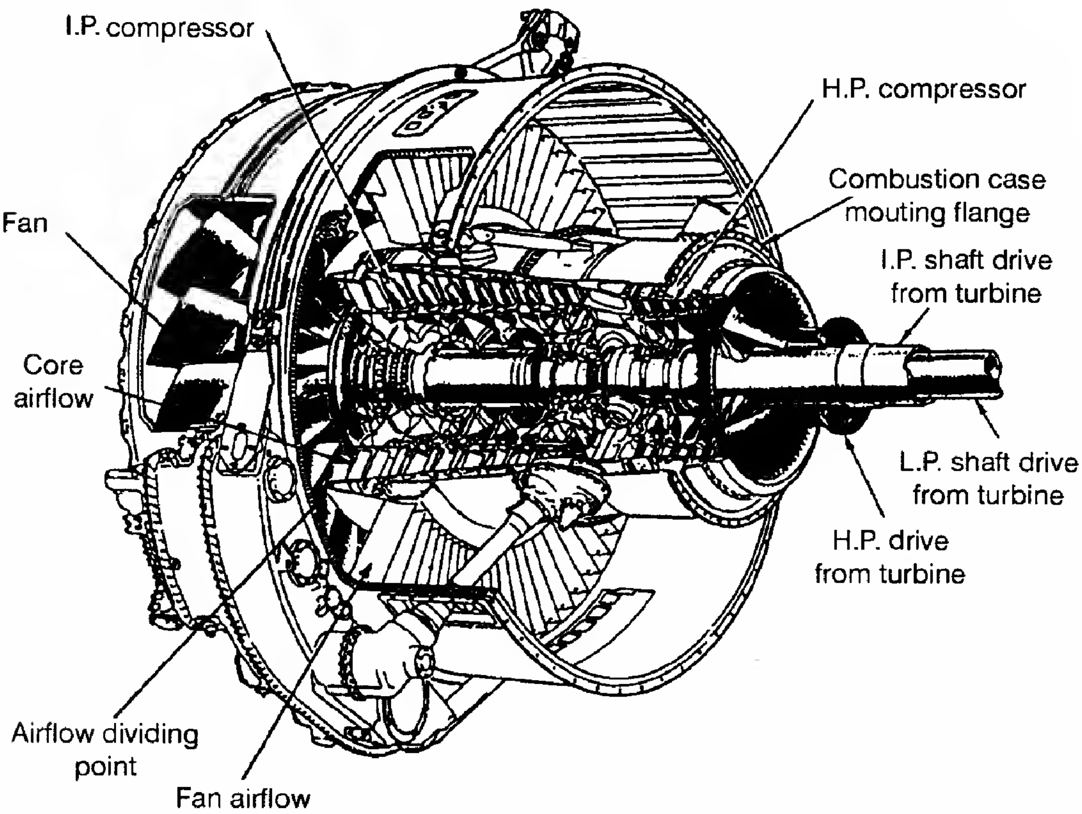


Fig.12.1. Gas turbine engine

Working Cycle

The working cycle of the gas turbine engine is similar to that of four-stroke piston engine. However, in the gas turbine engine, combustion occurs at a constant pressure, whereas in the piston engine it occurs at constant volume. Both engine cycles show that in each instance there is induction, compression, combustion and exhaust. In the piston engine the cycle is intermittent, the piston being the item concerned on all four strokes. The turbine engine, in contrast, has a continuous cycle with a separate compressor, combustion system, turbine and exhaust system. The continuous cycle and absence of reciprocating parts give a smoother running engine and enables more energy to be released for a given engine size. As it has been stated already, combustion occurs in the gas turbine engine at a constant pressure with an increase in volume; therefore, the peak pressure that occurs in a piston engine is avoided. This allows the use of lightweight, fabricated combustion chambers and low octane fuels, although higher flame temperatures require special materials to ensure a long life for combustion chamber and turbine components.

Because the turbo-jet engine is a heat engine, the higher the temperature of combustion, the greater the expansion of gases. The combustion temperature must however not exceed a value that gives a turbine gas entry temperature suitable for the design and materials of the turbine assembly.

There are three main conditions in the engine working cycle during which these changes occur. During compression, when the work is done on the air; this increases the pressure and temperature and decreases the volume of air. During combustion, when fuel is added to the air and burnt; this increases the temperature and volume of the air, whilst the pressure remains almost constant, since the engine operates on a constant pressure cycle. During expansion, when the work is taken from the gas stream by the turbine assembly to drive the compressor; this decreases the temperature and pressure; whilst the volume increases. The efficiency with which these changes are made will determine to what extent the desired relations between the pressure, volume and temperature are attained. For the more efficient the compressor, the higher the pressure generated for a given work input; that is, for a given temperature rise of the air. Conversely, the more efficiently the turbine uses the expanding gas, the greater the output of work for a given temperature drop in the gas.

VOCABULARY

Four-stroke piston engine = motor cu piston în patru timpi
to release (r) = a da drumul
peak pressure = presiune maximă
reciprocating engine = motor cu piston
conversely = în schimb, invers
drop of temperature = cădere de temperatură

NOTES TO THE TEXT

WORD STUDY

I. **Efflux** – an action or process of flowing out, something that flows out

The **efflux** from the jet pipe is amplified by the ducted air.

II. **Extent, degree**

A point has three **degrees** of freedom; it can move vertically, horizontally or laterally.

The temperature in the furnace was 600 **degrees** centigrades.

The pressure falls to such a (n) **degree** that cavitation may result.
extent

These problems can be to some **degree** overcome by improving the design.
extent

PATTERN

Contrast or opposition

In the gas turbine engine, combustion occurs at a constant pressure, **whereas** in the piston engine it occurs at a constant volume.
while
whilst

The contrast can be emphasized by adding **on one hand, on the other hand.**

A hot engine will run on a weak mixture, **while on the other hand** a cold
whereas
whilst
engine requires a richer mixture.
On the other hand is often used alone, after a full stop.

In contrast to + noun

In contrast to the rich mixture needed to start a cold engine, a weak mixture is sufficient to keep a warm engine running.

EXERCISES

I. Comprehension

1. Define a gas turbine engine.
2. Describe the combustion characteristics in a gas turbine engine.
3. Types of materials used for combustion chambers.
4. Speak about the relation between pressure, volume and temperature in a turbojet engine.

II. **Translate into Romanian**, minding the bolded words:

The **air intake** or **intake manifold** of an engine is the passage through which air is taken into the cylinder. The **inlet** and **outlet** valves let the air in and out of cylinder. The **power input** is the power, which must be fed into a machine to make it work. The **power output** is the power delivered or sent out by an engine. The heat **output** is the amount of heat, which can be delivered. The factory **output is the** number of items produced by a factory. The **throughput** is the amount of oil, gas, water, etc. which is pumped through a pipeline.

III. **Use comparatives of adjectives** to link these patterns:

Model : *The ultimate allowable stresses are high. The structures are light.* *The higher the ultimate allowable stresses, the lighter the structure.*

1. The number of fittings is small. The structure is light. 2. The velocity of the steam is high. The turbine speed is great. 3. The steel is hard. It is difficult to work. 4. The shaft rotates fast. Much friction is developed. 5. The fuel/air mixture is rich. The temperature in the engine is high. 6. The temperature of the air entering the impeller is low. The pressure for a given moment of work is high. 7. The compressor is efficient. The pressure generated for a given work input is high. 8. The temperature of combustion is high. The expansion of gases is great.

IV. **Use time statement** (*before, by the time, while, whilst, as soon as, when, once, after*) to translate the sentences below:

1.Amestecul carburant este aprins înainte ca pistonul să ajungă la capătul cursei. 2. El continuă să ardă până când combustia este efectuată complet. 3. Supapa de admisie este deschisă când pistonul se apropie de sfârşitul cursei. 4. Odată ce toate gazele de evacuare au fost ejectate, supapa de evacuare se închide. 5. După ce un ciclu se termină, începe un altul. 6. Supapa de admisie este acționată de mişcările plutitorului, pe măsură ce nivelul combustibilului se ridică sau coboară în camera plutitorului. 7. În timpul admisiei, în timp ce pistonul se mişcă în jos, combustibilul este aspirat şi pulverizat.

V. **Use the contrast words**, as in pattern I, to link these statements:

1.Unlubricated bearings develop a great deal of friction. Bearings, which are properly lubricated, develop much less. 2. Insufficient air will prevent complete combustion. Water has a variable coefficient of expansion. 3. The traffic density on the road is very high during the peak hours. It is very low at midday and during the night. 4. In the piston engine the cycle is intermittent. In the turbine engine, the cycle is continuous. 5. Uranium 235 requires slow neutrons for its fission. The neutrons emitted during fission are fast neutrons. 6. Fuels rich in paraffin are liable to detonation. Aromatics are antidetonators. 7. A belt drive provides a flexible link between shafts. A chain drive provides a positive link.

VI. **Give an oral account** of the following:

The radial, in line and opposed of flat types are three most widely used piston engines. In the radial type, the cylinders are arranged in a circle, in one, two, three or four rows. In the in-line type, whether liquid or air-cooled, the cylinders are arranged in fore and aft rows. Engines, in sizes

over 1,000 VHP, are either liquid or air-cooled. Take an example of the cooling system; after passing through the cylinder walls, the heat generated by the fuel air mixture burning inside the cylinder, can dissipate rapidly.This rapid dissipation of the heat is promoted by the large surface of the fins which cover the cylinders almost completely and allows the heat to escape. The cowling surrounding the engine is designed to control the airflow about the fins.

13 Compressors

In the gas turbine engine, compression of the air before expansion through the turbine is effected by one of the two basic types of compressor, one giving a centrifugal flow and the other an axial flow (fig. 13.1). Both types are driven by an engine turbine and are usually coupled direct to the shaft. The centrifugal flow compressor is a single or two-stage unit employing an impeller to accelerate the air and a diffuser to produce the required pressure rise. The axial flow compressor is a multi-stage unit employing alternate rows of rotating (rotor) blades and stationary blades, to accelerate and diffuse the air until the required pressure rise is obtained.

With regard to the advantages and disadvantages of the two types, the centrifugal compressor is usually more robust than the axial compressor and is also easier to develop and manufacture. The axial compressor, however, consumes far more air than a centrifugal compressor of the same frontal area and can also be designed for high-pressure ratios much more easily. Since the airflow is an important factor in determining the amount of thrust, this means that the axial compressor engine will also give more thrust for the same frontal area. With the higher-pressure ratios, there is a higher engine efficiency and performance due to an improved specific fuel consumption and specific thrust.

The centrifugal flow compressors have a single or a double-sided impeller and occasionally a two-stage sided impeller is used, as on the Rolls-Royce Dart. The impeller is supported in a casing that also contains a ring of diffuser blades. If a double-entry impeller is used, the airflow to the rear side is reversed in direction and a plenum chamber is required. The impeller is rotated at a high speed by the turbine and air is continuously induced into the centre of the impeller. Centrifugal action causes it to flow radially outward along the vanes to the impeller tip, thus accelerating the air and also causing a slight rise in pressure to occur.

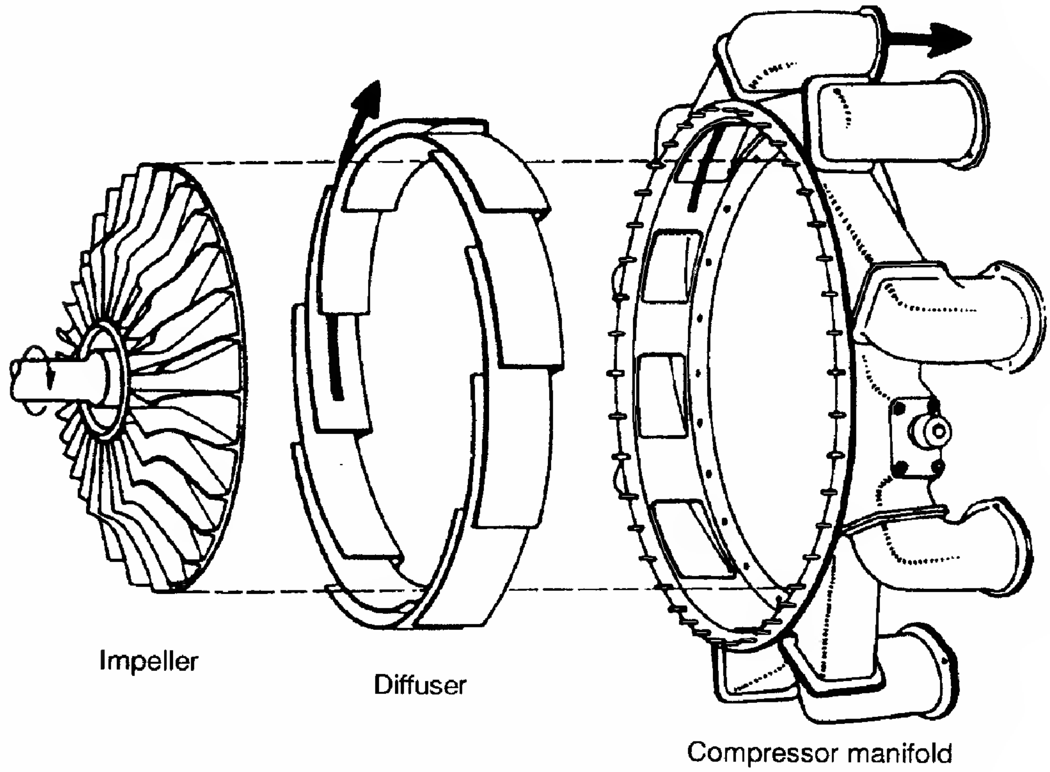


Fig.13.1. Centrifugal compressor components.

The engine intake duct may contain vanes that provide an initial whirl to the air entering the compressor (fig. 13.2).

The air leaving the impeller passes into the diffuser section where the passages form divergent nozzles that convert most of the kinetic energy into pressure energy. In practice it is usual to design the compressor so that about half of the pressure rise occurs in the impeller and half in the diffuser. The air mass flow through the compressor and the pressure rise depend on the rotational speed of the impeller, therefore, impellers are designed to operate at top speeds of up to 1,600 ft/sec. By operating at such high top speeds, the air velocity from the impeller is increased so that greater energy is available for conversion to pressure.

Another factor influencing the pressure rise is the inlet air temperature, for, the lower the temperature of the air entering the impeller, the greater the pressure rise for a given amount of work put into the air by the impeller. To maintain the efficiency of the compressor, it is necessary to prevent excessive air leakage between the impeller and the casing; this is achieved by keeping their clearances as small as possible.

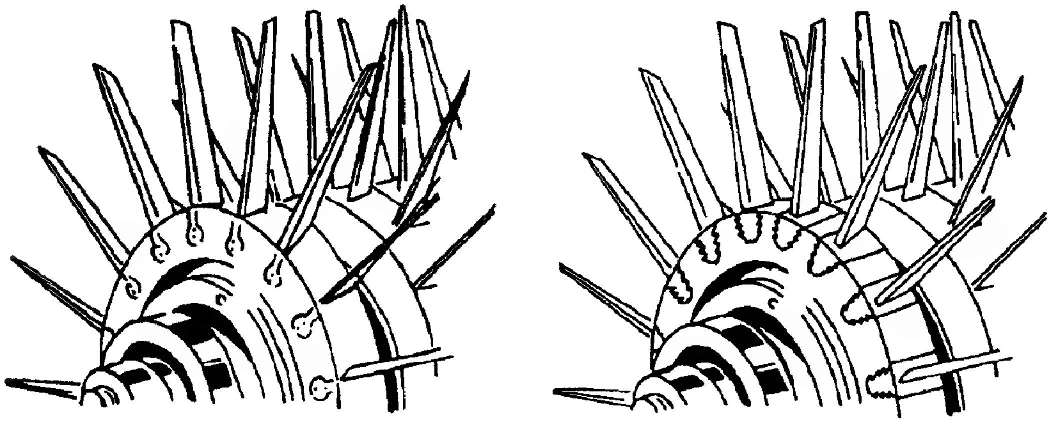


Fig.13.2. Common retention methods used on compressor rotor blades.

VOCABULARY

shaft = arbore
two stage compressor = compressor cu două trepte
impeller = rotor
blade = paletă
stationary blade = paletă fixă
casing = carcasă
double entry impeller = rotor cu dublă intrare
vane = paletă, aripioară
whirl = vârtej
nozzle = ajutaj
leakage = scurgere
diffuser = difuzor

NOTES TO THE TEXT

WORD STUDY

Stage, section, phase

1. A system of multi-**stage** compression is often used.
   The pressure is raised in **stages**.
   Turbo-compressors have several **stages** of compression.

2. The first **stage** of building operation was completed
   section
   phase
   part

3. The machine was built in **sections** for ease of transport.

   The first 5 mile **section** of the road has already been completed.

4. The camshaft **rotates in phase** with the crankshaft.

   Alternating currents are **out of phase** when they reach their greatest strength at different moments.

   A **three phase winding** has three coils, each one 120° **out of phase** with the next.

PATTERNS

I. Conditions (*if*)

If + Present

If the nozzle is properly designed, the steam flow	is will be	smooth.

Unless is equivalent of "if ... not".

Unless the water is pure, it	needs will need	further treatment.

II. Conditions (Restrictive)

In addition to the ordinary "if" clause, we can express conditions in a more restrictive way:

The pressure will increase	**providing** **provided** (that) **on condition**	the temperature is raised in the cylinder.

III. **Notice these idiomatic expressions**:

The centrifugal compressor differs from the axial one
from certain points of view
in certain respects
features
ways

from the point of **with regard to** **in**	airflow

in being more robust

in that **in so far as** **in as much as**	it is more easier to manufacture

EXERCISES

I. **Comprehension**

Fill in the blanks with the right words in order to render the ideas of the text:

In the gas turbine engine, compression of the air before... through the turbine is effected by one of the two basic types of compressor, one having a ... and the other ... The centrifugal flow compressor is a ... or ... unit. It implies an ... to accelerate the air and a ... to produce the required pressure rise. The axial flow compressors is a multi-stage unit, employing alternate rows of ... and ... , to accelerate and diffuse the air until the required pressure rise is obtained. The airflow is an important factor in determining the amount of ... The higher ...., there is a higher engine efficiency and performance due to an improved specific fuel consumption. If a double-entry ... is used, the airflow to the .... side is reversed in direction and a .... is required. Centrifugal action causes the impeller to ... radially outwards along the vanes to the impeller tip. Impellers are designed to operate at ... speeds of up to 1,000 ft/sec. To maintain the efficiency of the compressor, it is necessary to prevent excessive air ... between the impeller and the casing. Another factor influencing the pressure rise is the ... air temperature.

II. **Fill in** with one of forms of the following words: *contain, consist, comprise, constitute, include.*

The packet ... 20 cigarettes. The tank ... 100 gallons of gasoline. The atmosphere .... a number of gases. The moisture ... was increased in time. The tank is a large ... for holding liquids. The resultant force acting on an aircraft wing may be solved into a vertical and horizontal ... The axial flow compressor ... alternate rows of rotating and stationary blades.

III. **Complete these statements** with the correct form of the verb:

1.If a double-entry impeller (to be used), the airflow to the rear side (to be reversed) in direction. 2. If the turbine speed (increase), the governor automatically (come) into operation. 3. If the supply of coolant (fail) emergency controls (operate) immediately. 4. The cylinder temperature (rise) if the quantity of steam flowing through the cylinder (to be increased). 5. If the fuel (reach) the critical point, it (ignite) spontaneously. 6. The mixture (may) ignite spontaneously unless combustion chamber (to be designed). 7. If the gases (be allowed) to escape unburned there will be appreciable heat losses. 8. If the airspeed (fall) below a certain value, the airflow over the wings will be broken up. 9. If satellites (to be launched) into an orbit 22,000 miles above the Earth, they (take) 24 hours to make a circuit. 10. If the orbit (to be) parallel with the equator, the satellites (can be made) to stay permanently over a particular point on the surface.

IV. **Translate into English** using pattern II:

1.Acest proiect va fi acceptat cu condiția ca prețul să fie rezonabil. 2. Curgerea aburului prin ajutaj va fi lină cu condiția ca acesta să fie proiectat corect. 3. Motorul poate funcționa la viteze foarte mari cu condiția ca vibrațiile să fie amortizate. 4. Un reactor poate fi folosit ca să producă energie cu condiția ca un sistem eficient de transfer al căldurii să fie folosit. 5. Temperaturi de până la 700°C sunt acceptate cu condiția ca să se utilizeze aliaje special rezistente la căldură. 6. Un vehicul e considerat o rachetă cosmică cu condiția să se ridice deasupra atmosferei la 800 mile. 7. Schimbările de dimensiuni în timpul încălzirii nu sunt grave cu condiția ca piesa să fie prevăzută cu rosturi de dilatare. 8. Aceste zăcăminte de petrol merită să fie exploatate cu condiția să fie bogate. 9. Acest proiect va deveni o realitate cu condiția ca toate materialele necesare să fie livrate la timp. 10. Acest aparat poate fi folosit cu condiția ca toate caracteristicile sale de funcționare să fie perfect cunoscute.

V. **Complete the sentences** by practicing pattern III:

1.The Trident is similar to the Caravelle ... both aircraft have engines mounted at the rear of the fuselage. 2. This method is open to criticism ... not being sufficiently rigorous. 3. This is an ideal site for a factory ... it is close to the sources of supply of raw materials. 4. The new bridge is likely to prove very useful ... providing a direct route to the north. 5. The new bridge is likely to prove useful ... it will provide a direct route to the north. 6. The Trident is similar to the Caravelle ... having its engines mounted at the rear of the fuselage. 7. Rubber differs from synthetic plastic only ... it is produced naturally and not in the laboratory. 8. The gear pump has one advantage over the reciprocating pump ... it gives an even delivery of fluid. 9. This is a difficult course ... it involves a general knowledge of all branches of engineering. 10. This engine differs from the earlier one ... the bearings are made of white metal.

VI. **Translate into Romanian**:

An important problem facing the designer is to avoid the surge behaviour. Surge is an instability, associated in some way with stalling, which occurs when the flow through a compressor is reduced beyond a certain limit. The flow when surged can take many forms, although some flow reversal is a characteristic feature. The reversed-flow bands give rise to alternating loads of considerable magnitude on the blades and bearings, and if allowed to persist, they can wreck the compressor.

14 The Turbo-Prop Engine

The efficiency of a turbo-jet engine varies with the speed and altitude at which it operates. Whilst it is very efficient at supersonic speeds and high altitudes, it is not suitable to the low speeds involved in taking-off and landing. Under these conditions, thrust augmenters or after-burners are often required to boost the power, and this entails heavy fuel consumption and restricts the range of the aircraft. On the other hand, propeller-driven aircraft cannot attain speeds much in excess of 500 m.p.h., whereas at low speeds they have much better performance. Since subsonic speeds are still acceptable for most civilian airlines, a type of engine known as the turbo-prop was developed, which combined some of the advantages of both jet and piston-driven engines.

In the turbo-jet, the turbine is required to develop enough power to drive the compressor only, whereas in the turbo-prop engine, it must supply power also for the propeller, to which it is coupled by means of reduction gearing (fig. 14.1).

As the propeller rotates, it drives rearwards a much larger column of air than that which is expelled from the jet-tube of the turbo-jet, but at a much lower velocity. Consequently it is quieter than the turbo-jet, since the volume of noise produced by an aircraft engine increases with the velocity of the air column (fig. 14.2).

Most airports are situated in or near large centres of population, with the result that any reduction in the noise level is a decided advantage. Furthermore, a large proportion of the energy of the products of combustion is needed to drive the compressor and the airscrew. As this proportion increases, so the amount of thrust developed in the jet-pipe diminishes. In consequence, the destructive blasts of hot gas, which emanate from the jet-

pipe of the turbo-jet while taxiing on runways or taking-off, are greatly reduced. The main disadvantage of the turbo-prop engine is of course the limitation imposed on speed by the airscrew, as a result of which it is likely to become obsolete on all except short-haul aircraft.

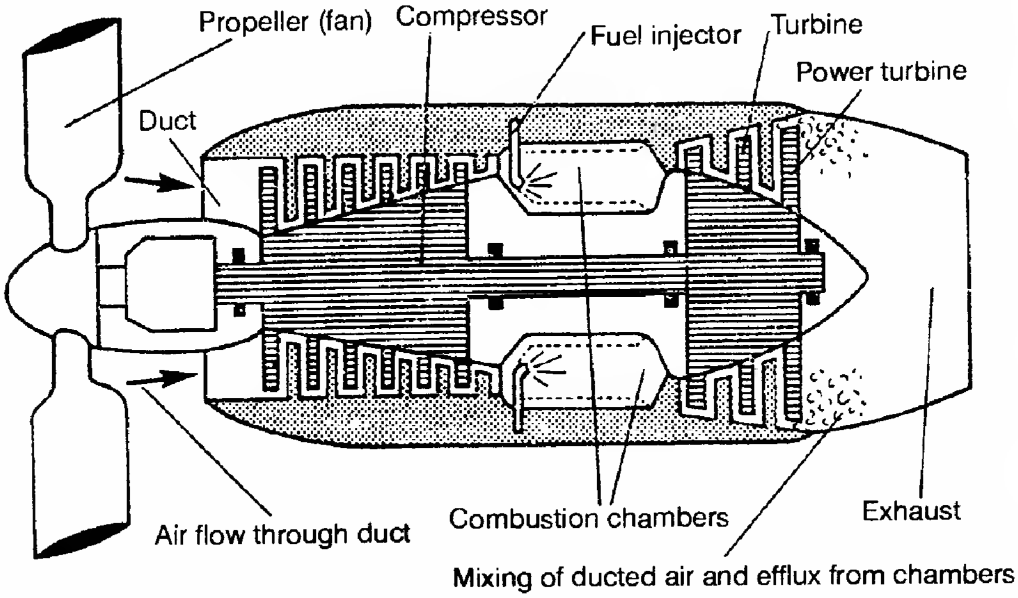


Fig.14.1. Cross-section of ducted fan engine.

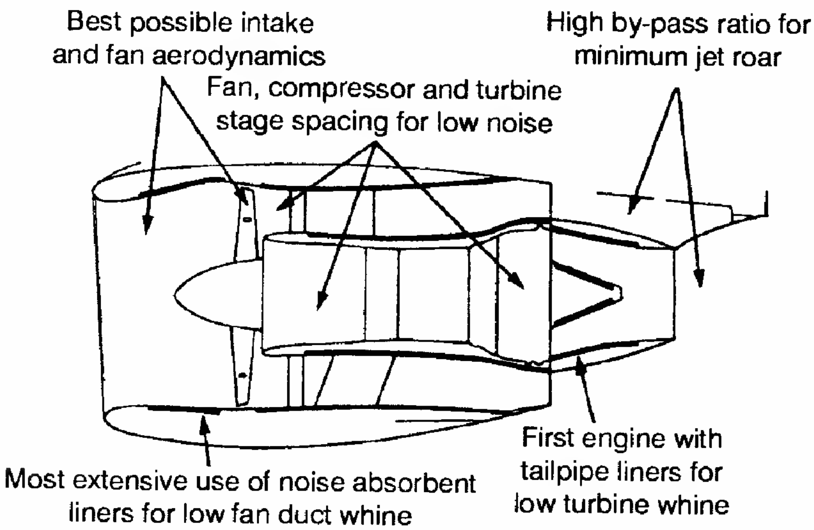


Fig.14.2. Noise reduction features.

A more recent development in jet propulsion is the ducted-fan-jet, in which the turbine drives a multi-blades fan enclosed in a duct (fig. 14.3). A certain proportion of the air which enters the engine by-passes the compressor and combustion chambers and, is impelled by the fan down the outside of the duct, so that it is expelled at considerable velocity from the rear of the engine. It amplifies the mass of the hot exhaust gases, and thus serves to augment the thrust derived from them. Consequent on the more moderate speed of this ducted air, the noise level is kept reasonably low. In addition, this type of engine performs well both below and above the speed of sound, whereas the other types of engin are efficient only at certain speeds.

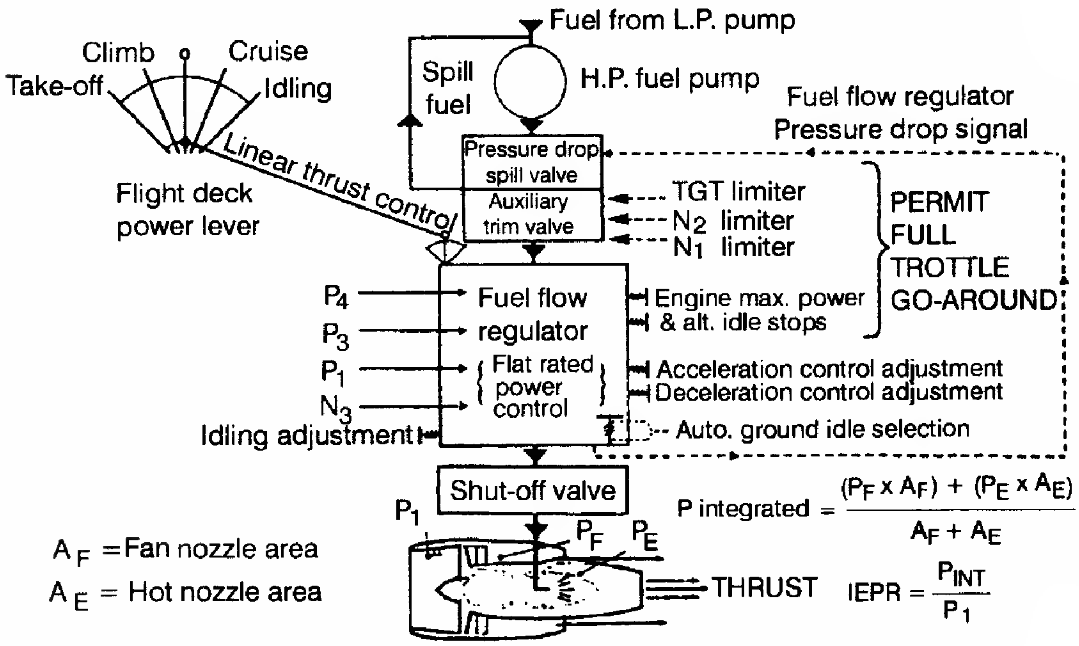


Fig.14.3. Powerplant operation.

VOCABULARY

to boost (r) =a mări, a spori
to entail (r)= a determina
airscrew = elice
blast = suflu, rafală, curent, explozie în aer
to by-pass (r) = a ocoli
to impel (r)= a roti

NOTES TO THE TEXT

WORD STUDY

1. To entail, to involve

The Diesel engine **involves** compressing the air to a very high pressure.
entails
Rapid compression of a gas **involves** a rise in temperature.
entails
A number of factors are **involved** in measurements of radiation dose.

II. To augment, to boost, to amplify, to diminish

The jet thrust may be **augmented** by after burners in the jet pipe.
The aircraft speed is **augmented** by the use of rackets.
boosted
The efflux from the jet pipe is **amplified** (made bigger) by the ducted air.
The steam enters each successive row of blades at a **diminishing** velocity.

III. To limit, to restrict, to impair, to impose

The length of the runway **restricts** the landing speed of aircraft.
limits
The limited flow space available **restricts** the size of the engine.
limits
The aircraft is **limited** in speed to about 5000 mph.
restricted
The usefulness of this machine is **impaired** by its low efficiency.
spoiled
The length of the runway imposes **limits on** / **limitations on** / **restrictions on** the landing speed of aircrafts.

PATTERN

RESULT (I)

a. The temperature of the gas rises. **Consequently** it expands in the cylinder.
After-burners have to be used. **Therefore** fuel consumption is heavier.
The aircraft speed is limited. **As a result** it will soon become obsolete.
Hence

The temperature of the gas rises, **so that** it expands in the cylinder.
After-burners have to be used, **with the result that** more fuel is consumed.

b. **As a result of** its rise in temperature the gas expands.
In consequence of having to use after-burners, more fuel is consumed.
Consequent upon its limited speed, the aircraft is now obsolete.
A rise in temperature of the gas **results in** its expansion.
The use of after-burners **leads to** increased fuel consumption.

EXERCISES

I. Comprehension

1. In what case does a turbo-jet become a turbo-prop?
2. What are the advantages of a turbo-prop?
3. What can you say of the propulsive efficiency of a turbo-prop and a turbo-jet in normal cruising range?

II. **Link these statements** using pattern I a:

1.The circulation in the unit is effected by gravity. No working parts are involved. 2.The friction losses are greatly reduced. They may be neglected. 3.The amount of thrust developed in the jet pipe diminishes. Destructive blasts of hot gases are greatly reduced. 4. Most airports are situated in or near centres of population. Any reduction in the noise level is a decided advantage. 5. The cooling water and condensate are kept separately. The condensate is not contaminated. 6. The draught is increased. More air is thus available for combustion. 7. There is a pressure and heat drop through the blades. The velocity of the steam increases. 8. The valve closes at some of the low-pressure nozzles. The speed drops. 9. A corrosive acid is liable to be produced. Special precautions have to be taken.

III. **Link these statements** using pattern I b:

1. Heating the metal in air. It oxidizes.
2. Lubrication of the bearings. The friction is reduced.
3. Working the metal cold. Internal stresses are set up in it.
4. A drop in pressure. Partial evaporation of the liquid.
5. Increased demands for power. Large capacity turbines were produced.
6. Increase in traffic density. Underpasses and fly-overs were built.
7. A rise in temperature. An increase in the pressure energy of the fluid.

8. The inefficiency of this type of engine. It was abandoned.
9. The development of the jet engine. Much greater speeds can be attained.
10. The overheating in the cylinder head. The mixture was detonated.

IV. **Fill in the blanks** with one of the following words: *inwards, downwards, sidewards, outwards.*

The flow was deflected .... The steam flow is along the axis of rotation of the shaft and therefore the blades radiate .... from the shaft. The exhaust steam from the first charge is driven ... through a blast pipe. The movement of the piston is transmitted to the crankshaft as an even turning movement.

V. **Translate into English** minding the sequence of tenses:

1. Verificarea atentă a motoarelor este o operație atât de importantă încât este făcută înainte de fiecare zbor. 2. Temperatura a scăzut atât de brusc încât termometrul s-a spart. 3. Ei aveau un instructor de zbor atât de exigent încât se calificau în mai puțin de 6 luni. 4. Limitatorul de presiune este astfel construit încât alunecă la aplicarea presiunii admise. 5. Pilotul a decolat atât de repede încât a fost imposibil să fie urmărit cu ochiul liber în ceață.

VI. **Summarize the main ideas** of the fragment below:

The fundamental difference between a turbofan and a turboprop is that the airflow through the fan is controlled by the design of the engine in such a manner that the air velocity through the fan blades is not affected very much by the speed of the aircraft. This means that the loss of operational efficiency at high airspeeds that limit the aircraft capability of turboprop aircraft is eliminated in turbofan aircraft. Indeed, supersonic aircrafts not only can, but are being powered by turbofans. They are rapidly becoming the most widely used of all types of jet engines, particularly in large multi-engine aircraft.

The turbofan is, in effect, a compromise between the good operating efficiency and high thrust capability of a turboprop and the high speed, high altitude capability of a turbojet. At cruising altitude, the engine propeller combination of a turboprop loses efficiency rapidly at airspeeds above 400 knots. Not only does the turbofan have no such limitation but it is much simpler than a turboprop. Another advantage of the turbofan is a lower noise level, which is an important feature at all commercial airports. Noise suppressors are devices designed to cut down the noise level without reducing engine performance. The purpose of thrust reverses is to ease the work of brakes in stopping an aircraft. They operate by deflecting forward the exhaust gases from the engine.

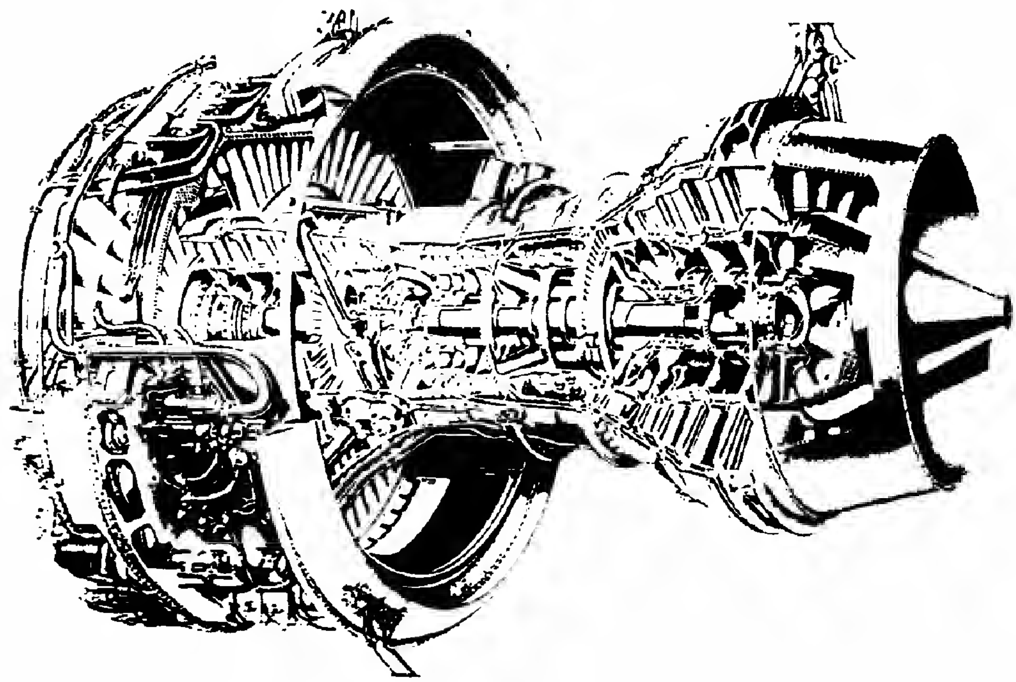


Fig.14.4. Turbofan.

The lower level of noise occurs because a turbofan engine has at least one additional turbine stage to drive the fan. Extraction of more power from the engine exhaust gases as they pass through the additional turbine serves to reduce the velocity of the engine exhaust. Less velocity through the jet nozzle results in less noise (fig. 14.4).

15 Vertical/Short Take-off and Landing

Vertical take-off and landing (VTOL) or short take-off and landing (STOL) are desirable characteristics for any type of aircraft provided that the normal flight performance is not unreasonable impaired. Until the introduction of the gas turbine engine for aircraft propulsion, VTOL could only be achieved by the helicopter.

Early in 1949 Dr. A.A.Griffith envisaged the use of the jet engine to provide lift thrust by changing the direction of the propulsive jet. In 1949 a light-weight jet engine was designed by Rolls-Royce, primarily for missiles, and from this engine the first pure lift-jet was developed for V/STOL application.

In 1956 Bristol Engines were approached with a proposal to use a turbo-shaft engine and a reduction gearbox to drive four centrifugal blowers, the blower casings to be situated on either side of the aircraft and capable of being rotated. The original conception incorporated two important ideas, i.e. fully variable thrust deflection and a thrust resultant acting near the centre of gravity of the aircraft. This principle was developed, using a pure jet engine with a free-power turbine driving a front fan that exhausted into a pair of swiveling nozzles. During 1957, a second pair of nozzles was fitted to the engine exhaust and, the first ducted fan lift propulsion engine (the Pegasus) was evolved (fig. 15.1).

Take-off technique, during the time from lift-off to wing-borne flight, depends upon the aircraft thrust/weight ratio and ground surface. For example, if the operation requires a VTOL aircraft to be overloaded for take-off, a short ground roll will be necessary to obtain some wing lift to supplement vertical thrust before the aircraft become airborne.

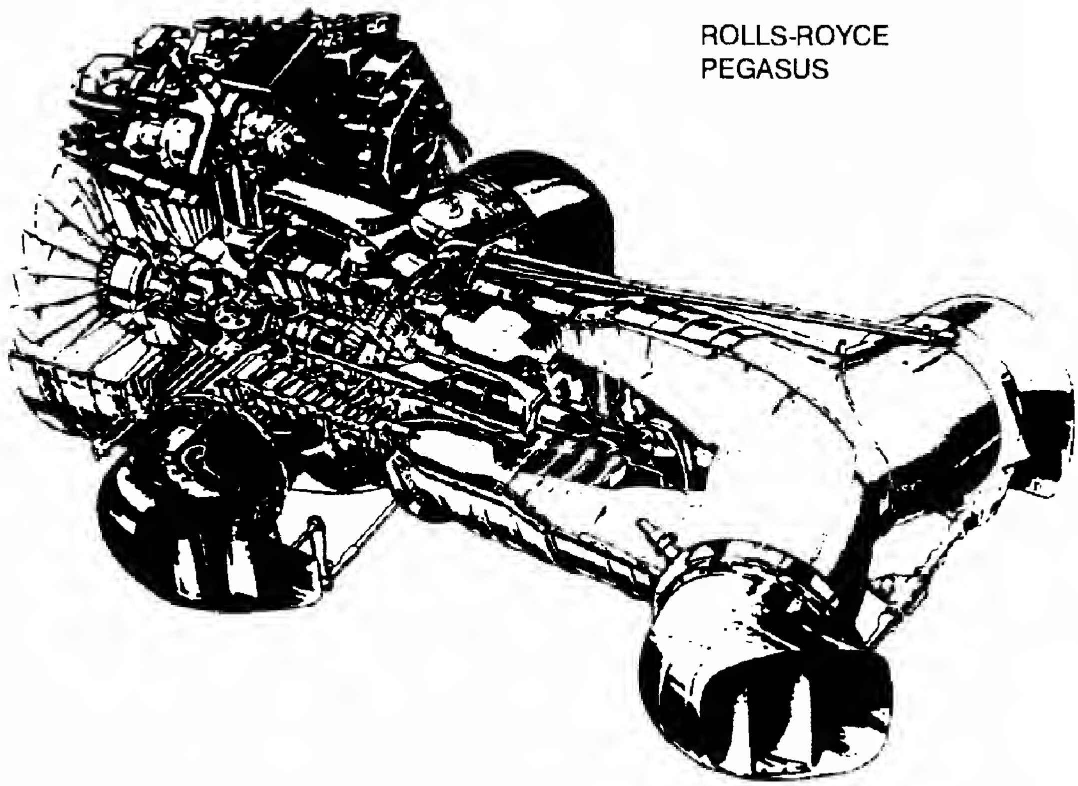


Fig.15.1. Pegasus – Vectored thrust turbofan.

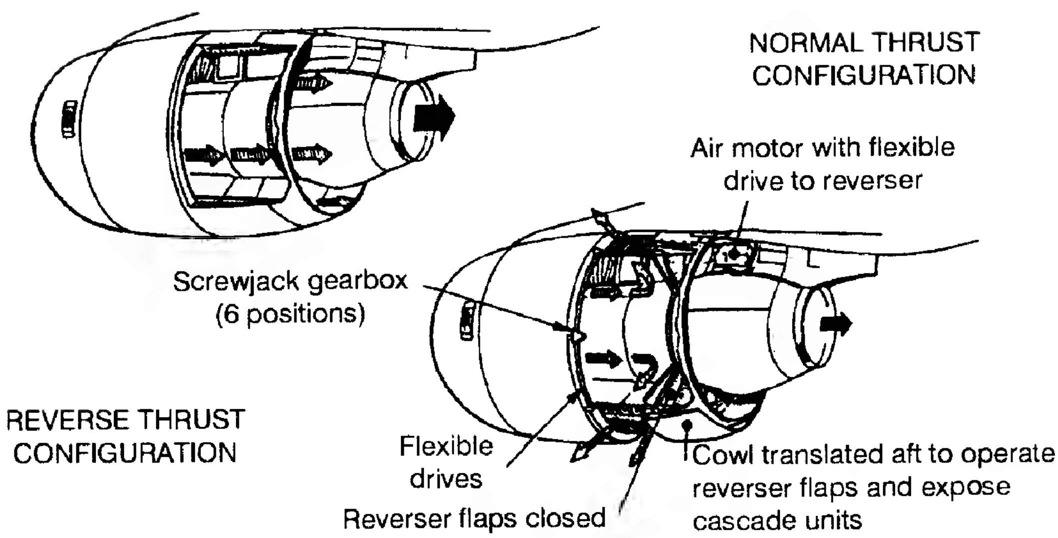


Fig.15.2. Thrust configuration.

There are several basic methods of obtaining jet, such as:

1. Deflecting the exhaust gases and vectoring, i.e., progressively varying the thrust angle of the exhaust gases;
2. Using specially designed lift-jets;
3. Driving a lift-fan either from the propulsion engine or from a gas producer;
4. Swivelling engines or pods.

Most V/STOL aircraft require additional lift engines to supplement the deflected or vectored thrust delivered by the propulsion engine and this combination of engine types is usually referred to as a composite powerplant (fig. 15.2).

Lift/Propulsion Engines

There are at least two types of lift propulsion engine. One is designed primarily to produce thrust for vertical take-off and landing, the other is optimized for wing-borne type. On both engines the exhaust gases can be delivered to provide a directional change of thrust. Aircraft fitted with the latter type of engine, however, require additional lift engines to augment the deflected thrust for VTOL. The directional change of thrust is achieved either by a device known as a switch-in deflector, or a diverter, that redirects the exhaust gases, or by a deflector system consisting of two or four swiveling nozzles that deflect and vector the exhaust gases. The diverter consists of a heavily reinforced door, which lies flush with the jet pipe wall when the engine is operating thrust. When deflected thrust is selected, the door moves to blank off the conventional propelling nozzles, thus directing the exhaust gas into the swiveling deflector nozzle. The nozzle can be mechanically rotated to vary the thrust angle and vector the exhaust gas, so enabling the intermediate braking and lift position to be selected. Due to its position when forward thrust is selected, the door has a negligible effect on performance, but is does carry a weight penalty. However, since the normal gas flow passes straight through the jet pipe, this system is particularly suitable for the application of after-burning. Swivelling nozzle deflector systems are used on by-pass engines.

On the two-nozzle system the exhaust gases are turned into an annular duct to mix with the by-pass air before passing through the nozzles at the rear of the engine. On the four-nozzle system the exhaust gases are ducted through the rear nozzles and the by-pass air through the forward nozzles. The nozzles can be rotated through approximately 100 degrees.

During forward flight, both the twin and four nozzle systems incur a performance loss due to the exhaust gases being continuously deflected through the nozzles. This result is an increase in specific fuel consumption.

On some installations engine thrust is augmented either by after-burning or by plenum chamber burning (P.C.B.). P.C.B. is a method of boosting engine thrust by burning fuel in the fan air stream in a combustion or plenum chamber immediately forward of the front swivelling nozzle. This appreciably increases the temperature and velocity of the fan air, thus boosting the thrust for take-off, landing, transonic acceleration and supersonic flight. The advantage of P.C.B. is that it makes possible the use of a smaller engine and improves the matching of engine performance to aircraft high-speed requirements; this results in an appreciable saving in the powerplant weight and gives an increased range and payload capacity.

VOCABULARY

to impair (r) = a diminua, a deteriora
blower = ventilator, suflantă
to swivel (r) = a pendula, a oscila
swivelling nozzle = ajutaj povotant
turboshaft = motor cu turbină
swivelling engine = motor cu schimbarea direcţiei unei rachete
swivelling pod = gondolă pivotantă
ground roll = rulaj la sol
by-pass engine = motor cu dublu flux
to incur (r) = a suporta
to blank off (r)= a elibera
ducted fan engine = motor cu suflantă canalizată
ground roll = rulaj de sol

NOTES TO THE TEXT

WORD STUDY

Mind the forms: To lie – lay – lain
To lay – laid – laid

PATTERNS

I. The Final – ing Clause

This type of clause has at least three different uses:

a. In place of " **and**". It is simple addition to the preceding statement. The subject of the second part is normally different from the subject of the first part and must be stated.

The stator motor is switched off, the engine **accelerating** under its own power.

b. In place of "**since**". It is an explanation of what has just been said. The subject of the second part is often the same as the subject of the first part and it is omitted.

The proton is the opposite of the electron, **being** a particle of positive electricity.

c. To show the results or consequences of the first statement. The subject of the second part is normally the same as the subject of the first part, so that it is not stated.

The door moves to blank off the conventional propelling nozzles, **directing** the exhaust gases into the swivelling deflector nozzles.

Frequently the words "**thus**" or "**thereby**" are added to emphasize the meaning.

The door moved to blank off the conventional propelling nozzles, **thus directing** the exhaust gas.

The nozzle can be mechanically rotated to vary the thrust angle and vector the exhaust gas, **thus enabling** the intermediate braking.

II. Alternatives

The directional change of thrust is achieved **either** by a diverter, **or** by the deflector system.

On some engines, thrust is augmented **either** by afterburning, **or** by plenum chamber burning. (PCB).

There are **several** alternative methods of lubricating bearings.

The temperature must not exceed 600°C	**or**	the metal.
	or else	will melt.
	otherwise	

This type of condenser will largely depend on **whether** (**or not**) there is plentiful supply of pure water.

EXERCISES

I. Comprehension

Answer the following questions:

1. What does VTOL mean?
2. What methods are used to obtain jet?
3. What is a composite power plant ?
4. Describe the two types of lift-propulsion engine.
5. What is PCB?

II. **Give the Romanian equivalents** to:

Airscrew blade, all metal blade, fixed blade, main-rotor blade, propeller-blade.

Coaxial rotor, folding rotor, front rotor, helicopter rotor, high-speed rotor, lifting rotor, main rotor, rear rotor, single bladed rotor, three-bladed rotor, twin-bladed rotor.

III. **Use the verb "to lay"** in translating the sentences:

1.Pune cuțitul imediat pe masă. 2. Pune masa pentru trei persoane. 3. Ei s-au aprovizionat din timp cu piesele de schimb necesare. 4. Reuşiseră să economisească o sumă mare de bani. 5. Fundația acestei clădiri a fost pusă acum o sută de ani. 6.. Furtuna puternică de săptămâna trecută a culcat la pământ aproape toată recolta. 7. Noi şine de cale ferată au fost instalate în această regiune. 8. Desenează harta regiunii noastre. 9.El întinsese corect vopseaua pe pânză. 10. Am insistat mult asupra acestei probleme.

IV. **Join these statements together**, using ***thus*** or ***thereby*** and the - ***ing form*** of the verb:

1. The surface area of pulverized fuel is greatly increased. The combustion process is hastened by this.
2. The steam is discharged into the water through nozzles. This brings about condensation.
3. The compressor may not be able to maintain the delivery pressure. This causes a reversal of flow.
4. The unburnt air can be burnt in the jet pipe. This increases the thrust from the jet.
5. The excess air mixes with the products of combustion. This lowers the overall temperature.

6. A thin steam of the fluid is forced through a Venturi tube. This has the effect of accelerating it.
7. A variable resistance is led to the rotor. This gives the motor a better starting torque.

V. **Insert** ***otherwise*****,** ***or else*****,** ***whether*****,** ***either…. or*****:**

1. Turbulent conditions are required in the combustion chamber…the flame will not propagate itself rapidly enough. 2.A flywheel is always fitted to the crankshaft …. the vibration would be excessive at low engine speeds. 3. The aircraft will have to jettison some of its fuel …. it will not be able to land safely. 4. The project must be carefully prepared before work is actually started …. a great deal of time will be wasted. 5. A compensator jet is necessary …. the carburettor will not work properly at low speeds. 6. Some means of cooling the compressed air is necessary …. the losses in the compressor will be large. 7. The use of …. aluminum … magnesium alloys is now quite common. 8. The fuel may be intimately mixed with the moderator or …. spaced at intervals through it. 9. He may come …by plane … by train. 10. The report can be held …. in English …. in Romanian.

VI. **Mind the** ***variables*** in the sentences below:

1. **The higher** the velocity of the steam, **the greater** the turbine speed.
2. **As** the velocity of the steam increases, (**so**) the turbine speed increases.
3. The specific heat of ice **decreases with** a reduction in temperature.
4. The magnetic field **increases with** and **decreases in** current.
5. The number of blades in each wheel **varies with** the temperature.
6. The number of blades **varies according** to the temperature.

VII. **Translate into English:**

Avioanele cu decolare şi aterizare scurtă prezintă numeroase avantaje. Ele sunt mai puţin complicate şi mai puţin costisitoare decât cele cu decolare şi aterizare pe verticală. Aripile acestor avione sunt fixe. Aceste avioane nu sunt prevăzute cu rotori, sisteme pivotante sau elice cu ax de rotaţie variabil (tilting propeller). Dar totuşi aceste avioane au un dezavantaj în sensul că nu sunt capabile să zboare pe verticală sau la un punct fix (hovering height).... De asemenea, ele necesită piste pe care să aterizeze şi, poate ceea ce este mai important, acest tip de avioane au nevoie de un spaţiu liber în care să execute manevrele de zbor şi să se alinieze pe pistă (to line up).

16 Helicopters (I)

Vertical take off and landing aircraft (VTOL) are all those machines including the helicopters, that have the ability to rise or descent vertically and to hover in the air. They include helicopters, tilt-prop and tilt-wing, jet VTOL and others. It is significant that almost all the VTOLs are also capable of making a running take-off that requires only the shortest of runways. They have the ability to land by descending vertically or by making a running landing with a very short forward roll. In modern aviation, helicopters find extensive application along with airplanes.

The helicopter is a flying vehicle having one or several lifting rotors. Actually the rotor serves two purposes: it provides the direct lift needed to make the machine to rise vertically and to support the ship in flight, and at the same time, by "leaning forward" slightly, it propels the craft through the air. The helicopter is superior to other VTOLs in its ability to pull itself straight up or to hover in the air. Thus, it is a direct rising and hovering aircraft. This is owing to the fact that a helicopter rotor offers the lowest thrust-to-weight ratio to vertical take off of all the various VTOLs; it can lift the most weight for the least amount of engine power (fig. 16.1).

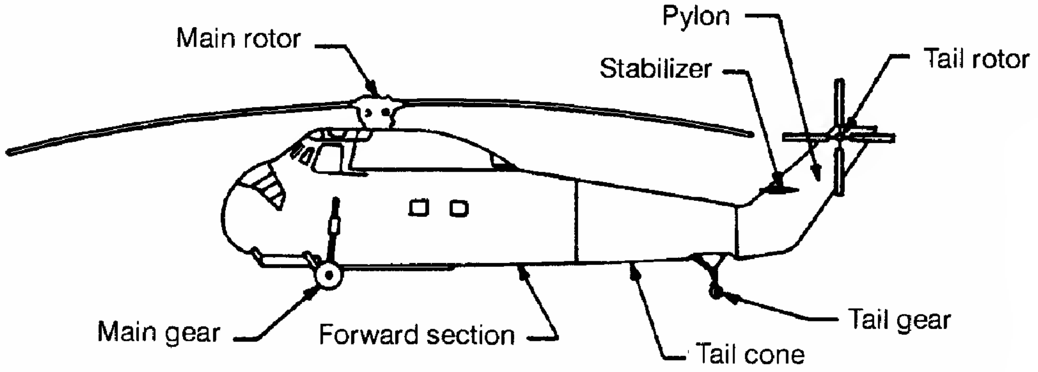


Fig.16.1. Typical helicopter structural components.

However, the helicopter is the slowest of all the VTOL. The fastest speed to be expected of a helicopter with a conventional rotor system, even the most powerful of the turbine-powered machines, is rarely over 200 miles per hour. The problem is that when the high speed of the helicopter is reached, a phenomenon termed "blade stall" occurs. This creates so much extra drag that a great deal of extra power is required, excessive vibration may be experienced, and there will be a troublesome - if not dangerous - loss in control as well. This is not to say that ultimately new rotor systems may not be developed to the point where this limitation can be overcome. Considerable research has been under way in this direction.

Another point to be considered is that if some form of direct thrust is provided – such as added jet engine mounted on the fuselage – the aircraft may then be forced to higher speeds despite the limitation of blade stall.

Since 1961 the engine has been progressively developed to increase power, reliability and overhaul life and is now in world wide service in both military and comercial versions. All Gnôme helicopter gas turbines are equipped with a fully automatic electro-hydraulic engine control system, providing precise governing of the free power turbine speed throughout the power range. The system also provides automatic starting and safeguards of the gas generator against overspeed, compressor stall, turbine overheating and rich or weak flame extinction in all flight conditions (fig. 16.2).

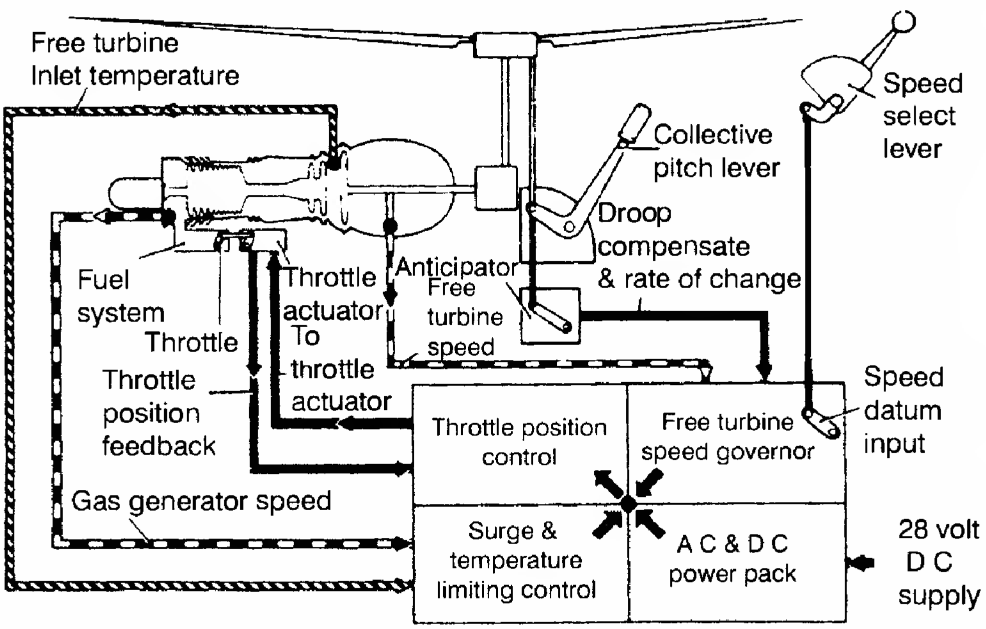


Fig.16.2. Automatic engine control.

A variation of the standard helicopter is the compound helicopter. In the last few years there was a revival of interest in the compound type, basically a standard helicopter redesigned with a propeller (or a jet engine) to give it added push (fig. 16.3).

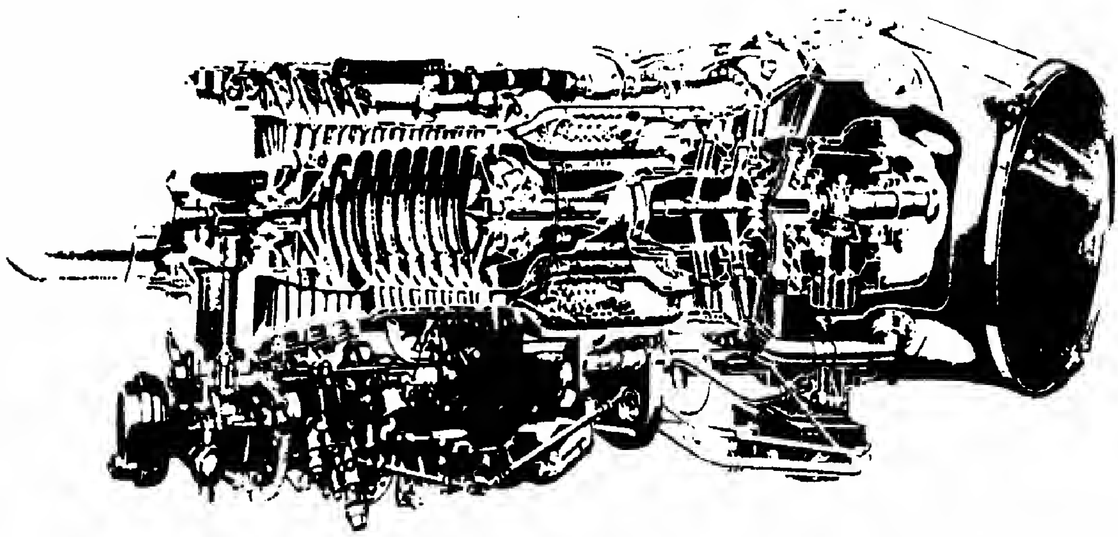


Fig.16.3. Turboshaft.

Usually a small lifting wing is also part of the configuration. The rotor is used for vertical take-off; after reaching altitude, power to the rotor is then reduced or stopped entirely and it is allowed to free wheel as the ship goes into forward flight. With the rotor thus unloaded it is possible to obtain a cruise speed considerably greater than that attainable with the rotor under power. For vertical descent, the rotor is clutched and, in effect, the machine is converted back to a helicopter.

The compound helicopter can be thought of as a kind of helicopter that can partially convert while in flight, to an airplane configuration by unloading the rotor. The intention is to combine the superior vertical flight and hovering characteristics of the helicopter with the high cruise speed available from use of an unloaded rotor. But there is a decrease in its vertical take-off and hovering capability, since the wing interferes with the airflow through the rotor; then, too, the added weight of this structure reduces payload.

VOCABULARY

to hover (r) = a pluti, a plana
hover plane = helicopter
to impart (r) = a împărți, a atribui, a da, a acorda
stall = angajare în limită de viteză, pierdere de viteză, trecere
peste incidenta maximă cu pierdere de portanță

NOTES TO THE TEXT

WORD STUDY

To attain, to achieve (reach)

The aircraft is capable of **attaining** / **reaching** / **achieving** a speed of 4,000 miles per hour.

A greater efficiency should be **attainable** / **achievable** with certain modification.

PATTERNS

I. **Formation of Adjectives**.

Scientists use a very large number of adjectives, which are made of verbs (or verb + suffix). These adjectives are purely utilitarian, and you will notice that in the three main types (-able, - ed, - ing) they simply take place of a verbal explanation.

workable metal = metal which can be worked
worked metal = metal which has been worked (Passive)
working fluid = fluid which does the work (Active)

II. **In spite of, although**

In spite of / **Despite** the limitations of blade stall, the aircraft may be forced to higher speed.
Although care has taken, there were a number of errors in the calculations.

EXERCISES

I. **Comprehension**

1. What purpose does the rotor of the helicopter serve?
2. What is the fastest speed of a helicopter?
3. What phenomenon occurs when the high speed of the helicopter is reached?
4. What variation of the standard helicopter do you know?
5. What is used for the vertical take-off of a compound helicopter?
6. What is done with the rotor for vertical descent of a compound helicopter?
7. Why is there a decrease in the vertical take-off and hovering capability of a compound helicopter?

II. **Give the corresponding adjectives** from the following verbs: *machine, notice, control, handle, practice, achieve, attain, expand, cool, lubricate, emanate*.

III. **Form the correct adjective** by completing the words between brackets:

1.Extended flaps are fitted to the (trail) edge of the wing to increase its (effect) area, and so make the aircraft more (control) at low speeds. 2. The (expel) gases provide the (require) (propel) force to drive the aircraft through the (surround) air. 3. Heat (resist) alloys are required to withstand the (exceed) temperatures produced by the burning of the (combust) mixture. 4. Each (succeed) stage of the pump receives the water at a greater pressure than the (precede) one. 5. Newly (construct) roads must be made wide enough to satisfy all (foresee) traffic requirements. 6. With the rotor unloaded it is possible to obtain a cruising speed considerably greater than the (attain) with the rotor under power. 7. A decrease in vertical take-off and (hover) capability has been noticed. 8. In order to rise vertically the flow from the turbojet engine is directed downward so a (lift) force is created. 9. A series of (rotate) blades and stationary vanes work on the air as it passes through the stages.

IV. **Translate into Romanian**, paying attention to the so-called "false friends".

1.Having answered an **advertisement** in the newspaper, he got himself a new job. 2. He has valuable **experience** in repairing cars. 3. The wheel slowed down its movement and **eventually** stopped. 4. A rapid **advance** has been scored since Liberation. 5. They were in deep **argument**. 6. Go to the **library** and lend the handbook. 7. **Actually** these principles have been

already familiar to you. 8. They **experience** difficulties on that problem. 9. This **fabric** is a new product of this textile mill. 10. The child has the **appearance** of being well looked after.

V. **Complete these statements** with ***in spite of***, then alter them for ***although*** and ***in spite of the fact that***:

1. ….the care which was taken, there were a number of errors in the calculations. 2. … the expense of multi-stage pumps, they are widely used as they can develop greater heads of liquid. 3. … the remedying of some of the defects by modifications to the engine, it is still not running satisfactory. 4. … being superheated, the steam is still wet. 5. … the allowance made for expansion stresses were set up in the metal. 6. ... the widening of the road wherever possible, it is still inadequate for the volume of traffic using it. 7. …... its fairly high resistance, steel wire is sometimes used as a conductor. 8. ....the higher capital expenditure involved, the machine may prove more economical in the long run.

VI. **Put the right tense of verbs** (***Past Tense, Past Perfect Tense***):

1.The engine (to prove) to be quite satisfactory for variable load conditions. 2.After he (to make) all the necessary calculations, the student (to begin) to design a new gear. 3. The new device which (to be designed) by some young engineers (to receive) high praise at the last international exhibition. 4. All the questions (to be discussed) when you (to come). 5. A great deal of information (to be obtained) about meteors from visual and photographic observation. 6. Within the past few years great advances (to be made) in the techniques of programming computers. 7. While the experiment (to carry out) nobody (to leave) the lab. 8. The automatic device (to be worked) much before, (to be put) into operation. 9. Special instruments measuring cosmic radio signals (to be tested) when he (to enter) the shop.

VII. **Render the main ideas** of the fragment:

An Original Type of Helicopter

Air under pressure is supplied to the blades by the propellant. Thus, the rotor is driven by the ejection of the compressed air through the blade tip nozzles. Therefore, the complicated transmission between the engine and the blades is eliminated. So is the anti-torque propeller. Placed in the jet of the exhaust gases of the turbine a rudder ensures the directional control. The metal blades of the two-blade type rotor are flexibly attached to the freely oscillating hub through leaf spring stacks. The three advantages offered by the formula are smooth power, reserve power and a high standard of safety in the event of turbine failure.

17 Helicopters (II)

"The energy crisis was the best thing that happened to the helicopter industry, both manufacturing and operating". This and similar comments underline the fact that the rotary-wing sector of the aerospace is alive and flourishing, the demand for new sources of petroleum has completely changed the economics of civil use.

Although the pioneers in the rotary-wing field proved that the helicopter was a practical vehicle, they were unable to solve all the problems. Only recently has real progress been made in acquiring satisfactory stability and control, and in increasing performance by extending the working limits of rotors. These limits were cramped between stalling on the retreating blades and compressibility effects on the advancing blades, accompanied by movement of the centre of pressure and drag divergence.

Once a manufacturer has established a satisfactory system for stability and control, the tendency has been to retain it for successive designs. The conventional layout has been a hinged blade mounting with a swash-plate for cyclic and collective incidence control, with various supplemental systems added (fig. 17.1).

Kaman has generally fitted servo-ailerons to the blades, this altering blade incidence via the pitch-change mechanism; an advantage is the improved stability of the blades, which helps make the machine less tiring to fly. Many Bell helicopters have a stabilizing bar at right angles to the two blades; its rotation provides a gyroscopic stabilizing effect, damping out the response of the helicopter to disturbances from equilibrium and preventing rotor tip path instability.

While several small helicopters are still being produced with piston engines, all medium and large designs in production today employ turbine power units. On the larger helicopters of the past, reciprocating engines

gave rise to severe vibration problems, particularly at certain rotor frequencies. The first helicopters with shaft turbines were tested early in the 1950's, although the French Alouette was the first turbine design to go into production. The shaft turbines develop their power at ten times the revolutions per minute of the piston engines and are generally light enough and small enough to be mounted on top of the fuselage or nearly "podded", leaving the cabin and crew space free of obstruction.

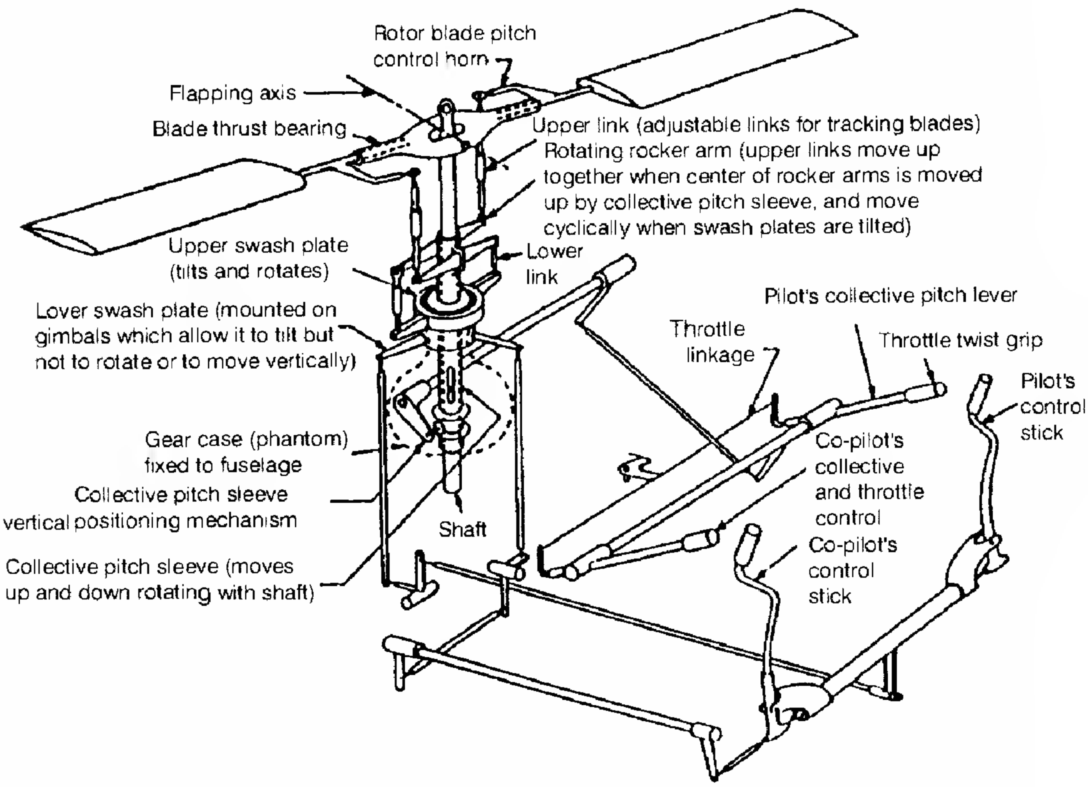


Fig.17.1. Helicopter control system.

As regards cruising speed, there has been considerable and continuous improvement by the use of turbine engines, with a smaller percentage for other reason. The combined effect is that average cruising speeds have climbed from about 140 km/h in 1945, for a reciprocating design, to some 260 km/h for recent engined helicopters.

Thirty years ago, the life of such vital components as the transmission, the rotor head and the blades was only one or two hundred flying-hours. The vibration from insufficiently damped rotors and reciprocating engines caused severe wear and tear throughout the airframe, with the result that servicing and replacing worn parts kept operating costs

very high. Today, the whole picture has changed; hingeless rotor system have eliminated some 60 per cent of the moving parts, and glass fibre reinforced blades have practically unlimited life. The accent among manufactures is on reducing the amount of overhaul, ease of maintenance and high reliability being the prime requirements.

VOCABULARY

to cramp (r) = a stânjeni, a înghesui
hinge = articulație
swash plate = platoul rotorului
pitch = pasul elicei
to tear - tore - torn = a rupe, a sfâşia
overhaul = reparație capitală
maintenance = întreținere
reliability = fiabilitate
shutdown = oprire

NOTES TO THE TEXT

WORD STUDY

Petroleum - British English
Oil - American English

PATTERNS

I. Forces (Impel, exert, act, balance)

The impeller blades **force** the water forwards.
drive
impel
The gases **exert** a force on the piston.
A lift force **acts** on the undersurface of the aircraft wing.
The aircraft must **develop** enough power to overcome the force of gravity.

II. **The particle "to" is not used after**:
– can, may, must, need (modal verbs)
– had better, would rather, would sooner,
– to make, to let, to help (with or without "to")

EXERCISES

I. Comprehension

Answer the following questions:

1. What real progress has been made recently in the field of helicopters?
2. What type of engine do helicopters have nowadays?
3. What are the shaft turbine characteristics?
4. What is the helicopter average cruising speed?
5. What are the manufacturer's prime requirements nowadays?

II. **Translate the sentences below**, paying attention to "*both*":

Both astronauts of Gemini spacecraft suffered considerable fatigue. **Both** of these methods are effective. **Both** the Apollo and Gemini spacecraft used the oceans as their landing area. The spacecraft crew experiences **both** acceleration and deceleration during a flight. **Both** piston and turbine engine are internal combustion engines. **Both** passive and active radio waves are now being used to explore the Moon, Sun, and near planets. The Moon is the major objective of **both** unmanned and manned astronautically explorations.

III. **Put the particle "to" before the infinitive**, if required:

1. I think they ought … go there. 2. Make them … go faster. 3. Help them … do this task. 4. Peter was made … read the text. 5. I saw him … go the institute. 6. You would rather … leave this place. 7. You would better …. stop to rest a little. 8. I heard them … come. 9. Let them …. do it. 10. They were requested …. complete the survey.

IV. **Translate into Romanian**, paying attention to the Gerund functions:

1.Peak temperatures occur after heating the test specimen. 2. The astronaut orbits the Earth 22 times before guiding his spacecraft safely back to a

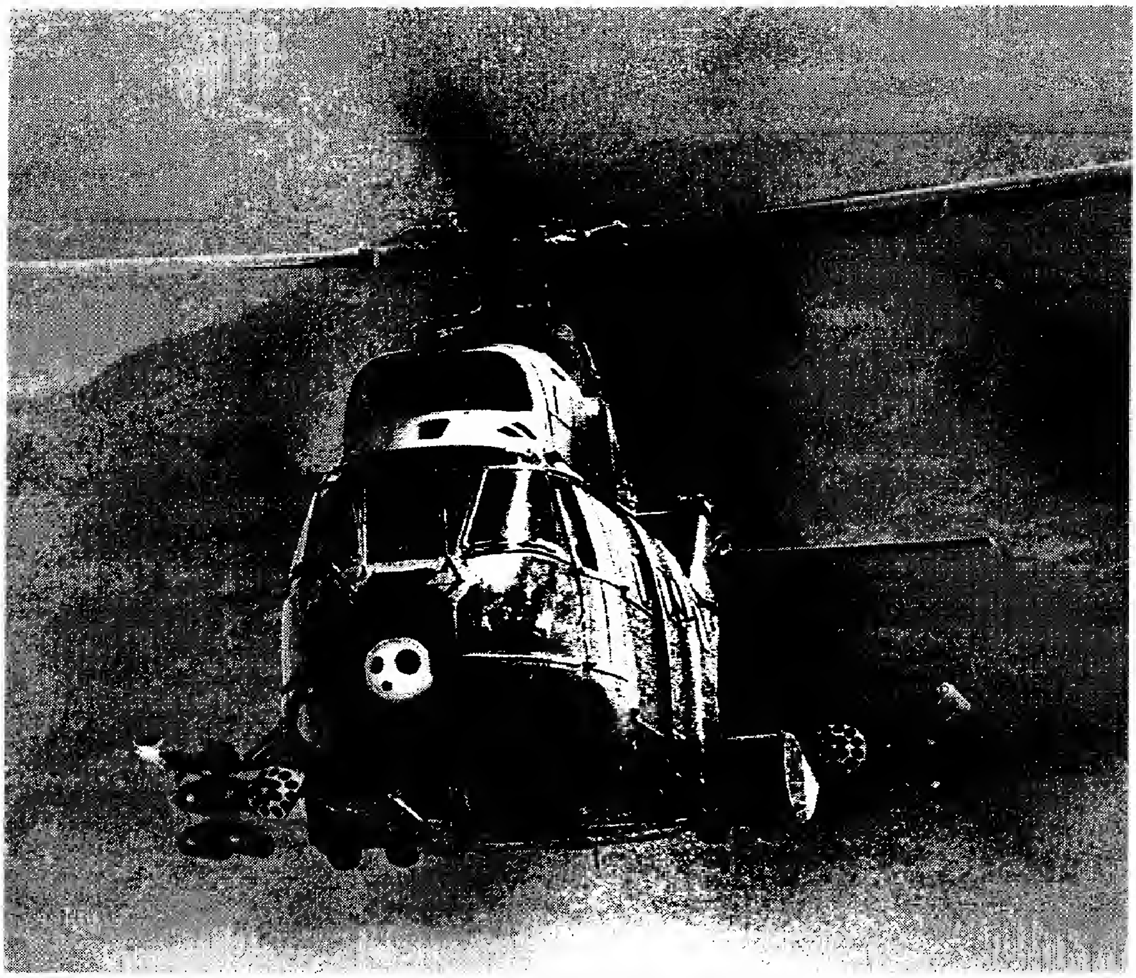
landing in the Pacific Ocean. 3. An interesting device for testing materials at high temperatures and speed is the supersonic shock tube. 4. Sometimes the buffeting of an airplane occurs only in a particular Mach number range. 5. Big rockets have been used for launching satellites into the Earth orbit. 6. Systems for detecting, inspecting and, if necessary, attacking enemy satellites and space vehicles can be either ground or space-based. 7. The automatic landing system must ensure landing the passenger airplanes at night. 8. The main advantage of the rocket engine is operating independent of its environment medium. 9. The purpose of the satellite was lifting the airborne instrumentation to a vertical distance of 250 miles from the surface of the Earth. 10. Launching a man or crew into a space can be accomplished in several ways. 11. The idea of flight has existed in man's mind from time immemorial. 12. Capillary forces prevent air from entering the tube. 13. The automatic opening of a parachute increases the chance of the pilot survival.

V. **Use contracted structures** to write the following statements:

Există trei metode de transmitere a căldurii. 2. Pentru ridicarea unei sarcini grele, câteodată se foloseşte un simplu mecanism. 3. După schimbarea acestei scule nu este nevoie de nici o reglare a dispozitivului. 4. Cercetătorii au pierdut mult timp încercând să găsească această relaţie. 5. Pentru legarea arborilor paraleli, se folosesc roţi dinţate cilindrice cu dinţi drepţi. 6. Limita de elasticitate a materialului poate fi definită ca tensiunea maximă la care poate fi supus fără să se producă o deformaţie permanentă. 7. Prin înlocuirea aripilor de aluminiu cu magneziu, inginerii au căutat să rezolve probleme de rigiditate. 8. Rezistenţa la oboseală se determină supunând corpul la solicitări prelungite. 9. Testând amestecul, cercetătorul a observat câteva cristale strălucitoare. 10. Mulţi piloţi visează să meargă pe lună şi pe alte planete îndepărtate.

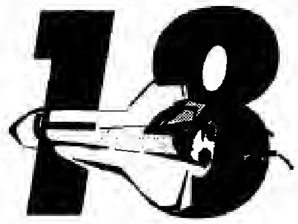
VI. **Translate into Romanian**:

An early use of helicopters was in agriculture. An incidental benefit, compared with fixed-wing crop spraying aircraft, is the fact that the downwash from the rotor blows plant foliage around, so that the chemical being dispersed reaches the undersides of the leaves, as well as the upper surfaces. Helicopters have been used for surveying mineral prospecting, for cable laying and inspection, in mountain rescue, and for charter and executive transportation.



The two civil operations for which the helicopter is suited are servicing oil rigs and for air-sea rescue. Oil rig resupply has received great attention in recent years. In British North Sea Oil – related work stage lengths of up to 150 nautical miles are flown regularly. Generally, helicopters are based on land to avoid the penetration of spray and salt-laden winds, and the operators prefer to carry sufficient fuel to the round trip to and from the platforms.

There is a natural desire for all weather-operation, which implies the use of twin-engined types and greater reserves of fuel, so that with some of the present helicopters,there is little range in hand. Operations divide into two main types: a) in support of exploration platforms, some of which require a large number of men to be moved on and off each week; and b) work in support of the production platforms, which require a more constant but less intensive support. Air-sea rescue has become another major activity.



18 Aircraft Instruments

Aircraft instruments are basically devices for obtaining information about the aircraft and its environment, and for presenting that information to the pilot in a concise form (fig. 18.1).

Their purpose is to detect, measure, record, process and analyze the variables encountered in flying by an aircraft. They are mainly electrical, electronic or gyroscopic. Aircraft instruments are concerned with the behaviour of engines, speed, height and attitude of the aircraft and its whereabouts.

A modern aircraft cockpit looks on first sight to consist of a bewildering of instruments that no human being could ever master or understand. It looks as though so much information presented symultaneously could never be absorbed by a small team of two or four people with any certainty (fig. 18.2). However, instrument panels are designed in such a way that instruments are grouped logically so that to a pilot it is an "open book".

Instruments Concerned with Flight Information

Height. An instrument for measuring and showing height above a level of reference is called an altimeter. It is basically an extremely sensitive aneroid barometer which measures static pressure at the height the aircraft is flying and, according to the difference between this and the pressure at a predetermined reference level, indicates height above reference level.

Vertical Speed. The rate of change in altitude is measured and shown by a vertical speed indicator. This indicates the speed of climb (ascent) or descend (dive or glide).

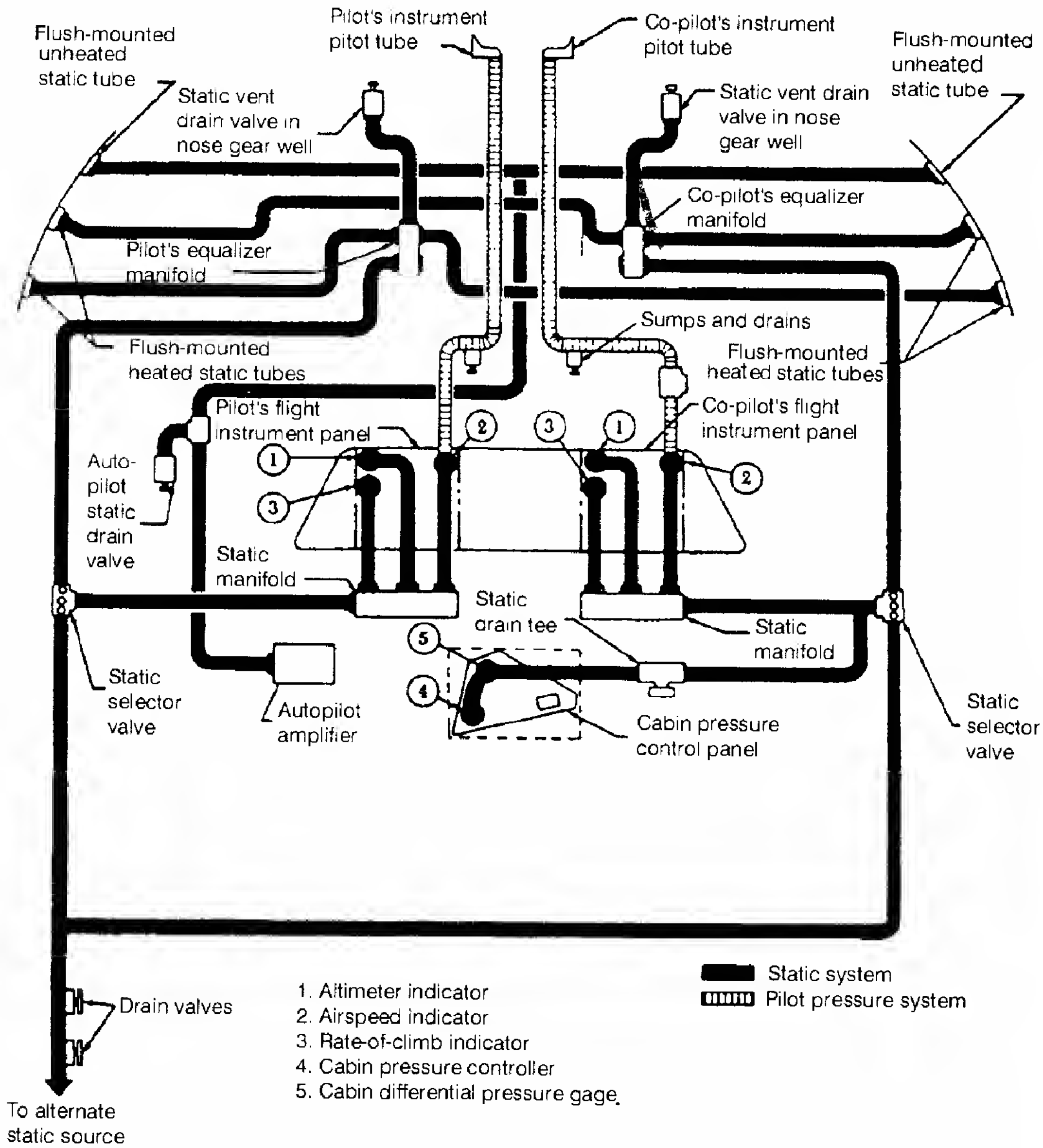


Fig.18.1. Schematic of typical pitot-static system.

Horizontal Airspeed. Horizontal airspeed is measured and shown by an airspeed indicator (ASI). It tells the pilot what his airspeed would be if he were flying at sea level under standard atmospheric conditions, temperature 59 °F (15°C) and barometric pressure 29.92 inches (760 mm). True airspeed (TAS) may be calculated approximately from indicated airspeed (IAS) by adding 2% to the IAS for every one thousand ft. about sea level.

The machmeter indicates the Mach number, which expresses airspeed as a fraction of the speed of sound. It is the essential equipment on jet engines.

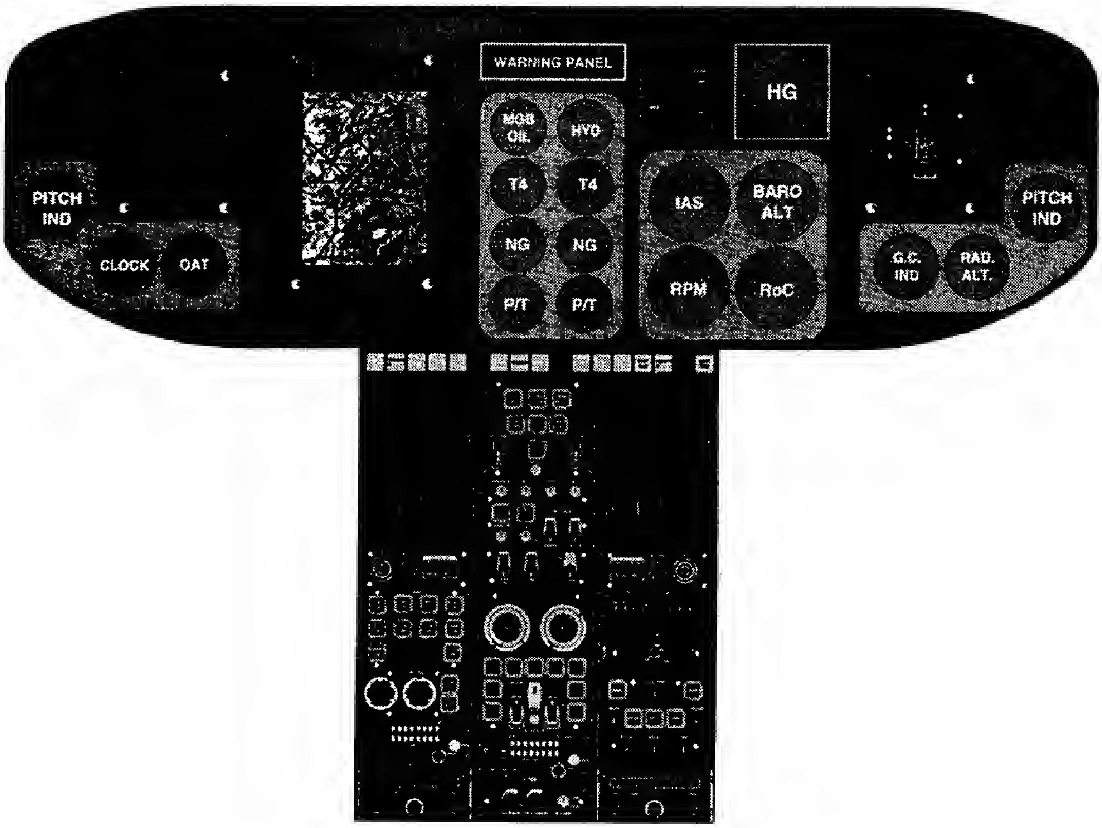


Fig.18.2. Control panel.

Turning Characteristics. Aircraft turning characteristics can be measured and shown by a simple device known as a turn-bank indicator. This tells the pilot two things. First, it tells him whether he is doing a tight turn or a wide turn, and whether it is to port or starboard. Secondly, it tells the pilot whether, on the turn to right or left, his aircraft is slipping inwards or skidding outwards. In big aircraft information on turning and banking is incorporated in a flight system direction indicator.

Attitude. The attitude of an aircraft relative to the surface of the earth is shown by an "artificial" or "gyro" horizon.There is a horizon bar on the instrument that always remains parallel to the surface of the earth. Another small piece of metal shaped to indicate the aircraft appears above or

below the horizon bar if the airplane is in a climbing or gliding attitude. When the aircraft is banked to the left or right the imitation airplane in the instrument appears banked to the left or right.

Direction. An elementary direction-measuring instrument is a simple magnetic compass which may, however, be inaccurate by a degree or two in straight and level flight and much more inaccurate in turns. The magnetic compass is used in conjunction with a directional gyro which is not affected by the angles of bank normally employed in airlines.

Instruments Concerned with Propulsion Information

Speed. Engine speeds are measured and shown on rpm indicator, which measure the revolutions per minute of the main rotor in each engine. Any difference in rpm from a master engine used as a basis for synchronizing are shown on a synchroscope.

Temperature. The temperature of each engine on an aircraft is measured and shown on a temperature indicator. Piston-engined aircraft have indicator for cylinder head temperature (CHT). Turbine engines have indicators for jet-pipe temperature (JPT) or turbine gas temperature (TGT). All types of engines have oil temperature indicators showing the temperature of their lubricants.

Pressure. Various sorts of pressure occurring in an operating engine are shown by instruments..A manifold pressure gauge is an instrument for measuring the absolute pressure in the induction system (a branched pipe for distributing air or a mixture to a number of cylinders) at a point standardized for each unit. Alternatively boost pressure, which is pressure in the induction system at a point standardized for each type of engine may be shown on a boost pressure gauge.

Oil pressure is indicated by an oil pressure gauge.

Instruments Concerned with Information about Fuel

Fuel content. Fuel tank contents indicators show how much fuel the aircraft has left at any moment of time. Usually each tank is measured individually and the amount of fuel is measured in litres or by weight.

Fuel Flow. The fuel consumption of each engine is measured by fuel flowmeters calibrated in kilos per minute. These are integrated in a device to indicate kilos gone since engines were started.

Instruments Concerned with Information about Conditions on the Outside of an Airframe

Temperature. The outside air temperature (OAT) gauge gives the pilot general information about the temperature of the air immediately surrounding the airframe. This will enable him to asses the influence of temperature on certain performance aspects of the aircraft. He needs to know particularly whether the temperature is within certain limits in humid conditions so that there is danger of ice forming. This enables action to be taken to heat the affected areas. Critical parts include the leading edges of wings, control surfaces of the tail unit, engine air intakes and the pitot head.

On the other hand, there are certain parts of the airframe that might possibly become overheated. Electrical temperature bulbs monitor the temperatures of important zones of the airframe in the vicinity of a heat-producing component.

VOCABULARY

whereabouts = prin ce parte, în ce direcție
to skid (r) = a derapa
skiddometer = aparat pentru măsurarea derapajului
array = ordin, dispunere
attitude = poziția unei aeronave în spațiu

NOTES TO THE TEXT

WORD STUDY

I. Metre, meter, measure

A kilometer is a thousand **metres**.
An am**meter** is an instrument for measuring the amperage of a current.

A volt**meter** is an instrument for measuring voltage.

An alti-**meter** is an instrument for measuring static pressure at the height the aircraft is flying.

The pressure of the steam is **measured** in lb/in^2.

Readings of the thermometer should be taken every ten minutes.

Measurements of temperatures.

II. **Estimate, Gauge, Judge**

The cabin temperature may be **estimated** by an automatic system
gauged
judged

III. Mind the following word combination:

elevon – (elevon+aileron)
flaperon – (flap+aileron)
motivator – (motion+elevator)
naviation – (naval+aviation)
naviator – (naval+aviator)
radiotronics – (radio + electronics)
transceiver – (transmitter + receiver)
transponder – (transmitter + responder)

PATTERN

Suppose

a. An instrument **would tell** a pilot if his aircraft **were** nose down.
b. An instrument **would have told** a pilot if his aircraft **had been** nose down.
a. ***If + Past, Subject + would + Infinitive*** (unreal)
b. ***If + Past Perfect, Subject + would have +Past Participle*** (impossible)

In this construction, **were** is used instead of **was**
be is sometimes used for **is**.

EXERCISES

I. Comprehension

Answer the following questions:

1. What is the purpose of aircraft instruments?
2. What does the history of the development of aircraft instruments show?
3. Speak about the radio altimeter.
4. What is an ASI?
5. What does the machmeter indicate?

II. **Give the Romanian equivalent** for:

cabin pressure gauge	climb indicator	airborne recorder
gasoline gauge	course indicator	airspeed recorder
Mach number gauge	bank indicator	flight path recorder
oil gauge	dive-angle indicator	pressure recorder
fuel pressure gauge	rate of climb indicator	altitude recorder
	rate of descent indicator	

III. **Translate into Romanian**, minding the bolded words:

1.A pressure **gauge** gives an indication of the pressure in the boiler. 2. A micrometer is a **gauge**, which gives a very exact measuring of size. 3. The surveyor **estimates** the quantity and cost of the materials. 4. In the **estimate** produced by the surveyor, the cost of each item is noted down. 5. The **estimated time of arrival (ETA)** of the flight 841 is 11.00. 6. It is **estimated** the world's oil resources will last for 100 years. 7. The fuel consumption of each engine is measured by fuel **flowmeters** calibrated in kilos per minute. 8. The cabin attitude **indicator** is the instrument monitoring passenger comfort. 9. A flight **recorder** stores present information for future reference. 10. Throughout the aircraft there are various heat, flame and smoke **detectors**, which relay their warnings to the pilot by bell, as well by light.

IV. **Put the verbs in brackets to the correct form**, according to the pattern:

1. If a spaceship (to be) lighter in weight the cost of its launching rockets (to be reduced) tremendously. 2. If an infinite number of sensors (to be used)

the control system (to be) correct at all times. 3. The accuracy of the system (to be improved) considerably if signals (to be transmitted) on two or more frequencies simultaneously. 4. If a rocket of this kind ever (to be fired) it (to drop) in the Pacific Ocean. 5. If thrust (to increase) and (to become) greater than drag the aircraft (to accelerate). 6. If thrust (to be decreased) drag (to cause) the aircraft to decelerate. 7. If outside forces (to disturb) a stable aircraft from its normal flight, the aircraft (to tend) to return eventually to its original position. 8. If the climate (to be) cold and the altitude (to be) low, the air (to be) dense and an airplane (to take off) at a much lower speed than if the air (to be) warm or at high altitude. 9. A problem (to be) of the spacecraft (to be protected) from meteoroids in a proper way. 10. The question (to be) whether or not the angle of attack (can be predicted).

V. **Translate these sentences**, minding the inversion of "*if*":

1. Should the retrorockets of the vehicle fail, reintry would occur. 2. Had the wall thickness been 0.116 in., instead of 0.25 in., the first natural frequency would have been 14 Hz. instead of 140 Hz. 3. Aeronautical engineering would have taken a different course had aluminum alloys with suitable properties not been developed. 4. Should the attitude control system of the vehicle fail, then a safe re-entry might be impossible. 5. Should this system detect an equipment malfunction, then telemetering signals regarding the defect would be transmitted to a ground station. 6. The crew of the spaceship will be able to determine their impact point, should they initiate re-entry procedure. 7. The astronaut occupied an ejector seat which enabled him to leave the cabin, should the need arise.

VI. **Translate the sentences below**, using "*as if*", "*as though*":

Mişcarea fluidului în regiunea de tranziţie poate fi tratată ca şi cum regiunea respectivă ar fi plană. La viteze mai mici de 480 km/h fluxul de aer din jurul unui avion se comportă ca şi cum aerul ar fi compresibil. Astfel de curbe speciale trebuie să fie analizate ca şi cum ar fi două sau mai multe linii curbe separate. Distanţa nu se calculează ca şi cum linia ar trece prin pământ, ci se măsoară pe suprafaţa curbă a pământului.

VII. **Give an oral account** of the following:

Dependant (External Reference) Navigation System

There are invisible roads built into the skies over Europe, America and many other parts of the world, where the air traffic is dense enough to justify the expense of maintaining them. These airways, sometimes called

air traffic lanes, are commonly constructed of beams of radio waves. A beam of radio waves is just as real to the pilot as a road of concrete is to the motorist. But a radio beam is not a two dimensional path like a road; it is three dimensional like a tunnel. At the end of each tunnel is some sort of radio transmitter. This sends out the radio signals that form the tunnel. In order to be able to make use of the airway the pilot has to tune a radio receiver in the cockpit to the frequency of the radio transmitter. Nowadays,most airways are defined by VOR station, though many are still using non-directional beacons (NDBs). NDBs are comparatively cheap and simple but have several major disadvantages, viz.a) they operate in the overcrowded "medium frequency" band, which is subject to static interference; b) as the name indicates, the radiation from NDB does not give the pilot a really positive "tramline", but only an indication that is now a on certain bearing from the aircraft. Whilst the aircraft is heading towards the NDB, its path may actually describe a parabola, due to drift caused by the local wing effect on the aircraft. The VOR (**Very High Frequency Omnidirectional Radio Range**) does not suffer from these disadvantages. It does provide a static free "tramline" down the centre of the airway, which it is easy for an aircraft to follow ,regardless of crosswind effect.

19 Spacecraft Propulsion

One of the most critical systems on a spacecraft is its propulsion system. If the propulsion fails, the spacecraft will be unable to return from mission and the lives of the crew will be lost.

The propulsion systems on spacecraft are selected primarily on the basis of reliability as opposed to performance. Solid rocket motors are used whenever they are suitable, since a solid motor is simple and can be made extremely reliable. In the many applications for which solid rockets are unsuitable, liquid rocket using hypergolic, noncryogenic propellants are used. Hypergolic propellants will ignite upon contact and therefore the rocket engine needs not to be equipped with an ignition system (fig. 19.1).

The avoidance of the use of cryogenic propellants, which must be kept in insulated containers, greatly simplifies the spacecraft's propellant storage and feed systems. Only pressure-feed propulsion systems are currently being employed on manned spacecraft. In such systems, the force required to cause the propellants to flow into the rocket combustion chamber is created, by pressurizing the propellant tanks with helium gas. Helium from high-pressure storage bottles is fed into the propellant tanks at the desired pressure through pressure regulation valves. Compared to conventional pump-feed propulsion system, a pressure feed system is considerably heavier since the propellant tanks must be made stronger and a great deal of helium pressurant must be carried in high pressure containers. On the other hand, many simplifications are achieved. For instance, the number of valves and controls for start and shutdown are greatly reduced and the rocket motor's turbo pump is eliminated.

Spacecraft are all equipped with small auxiliary rockets, used for attitude control and minor manoeuvres. They may also carry large main propulsion systems for major manoeuvres (fig. 19.2).

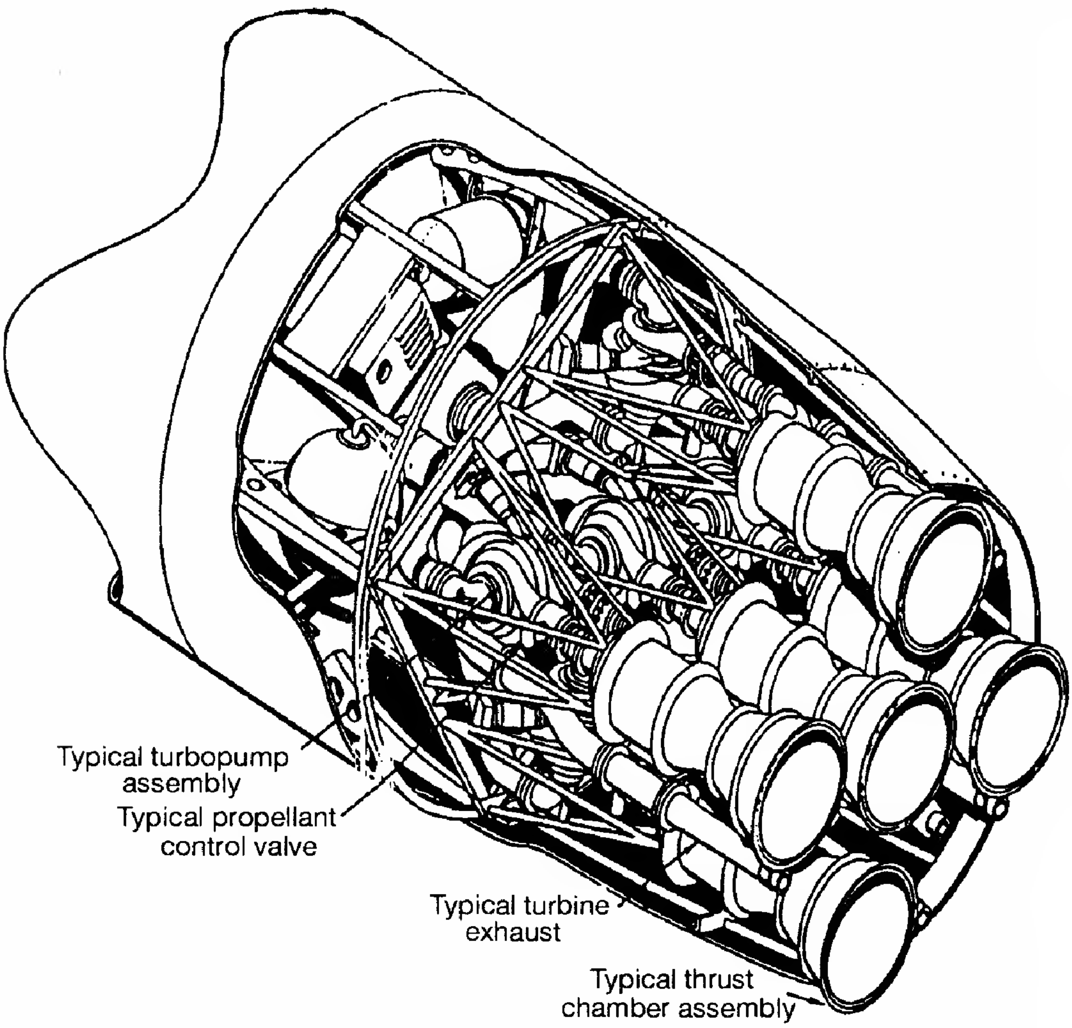


Fig.19.1. Spacecraft propulsion engine.

It is common practice to carry an excess of auxiliary rockets arranged in a manner so that one of more of these rockets may fail without crippling the spacecraft. On the other hand, it is not practical to carry more than one main propulsion system. Therefore this design must be extremely reliable. One approach is to use redundant components wherever it appears to be practical. For instance, four valves arranged in a series – parallel arrangement might be used to replace a single valve. Such an arrangement protects the system against either a failure to open or a failure to close (fig. 19.3).

Spacecraft propulsion system must be capable of starting in the weightless environment. It is therefore important that the propellant storage tank be arranged so that propellants rather than helium will always be transferred to the engine.

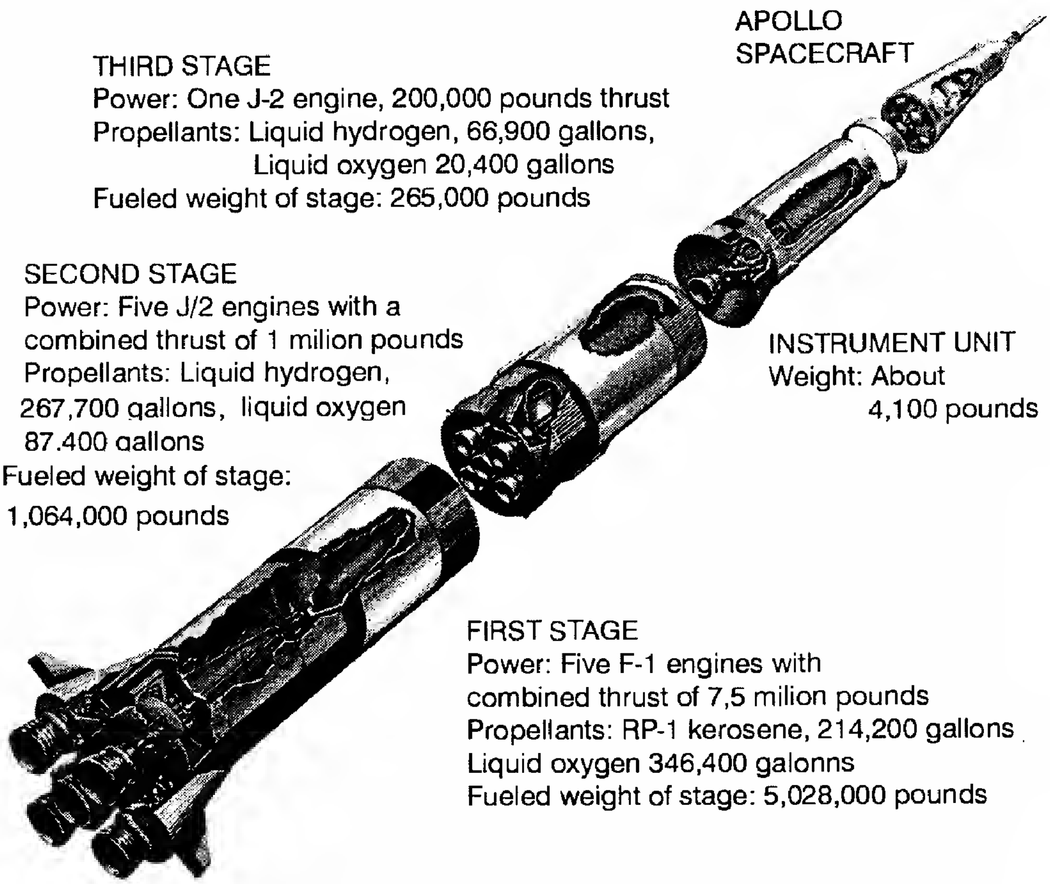


Fig.19.2. Saturn V – Space vehicle.

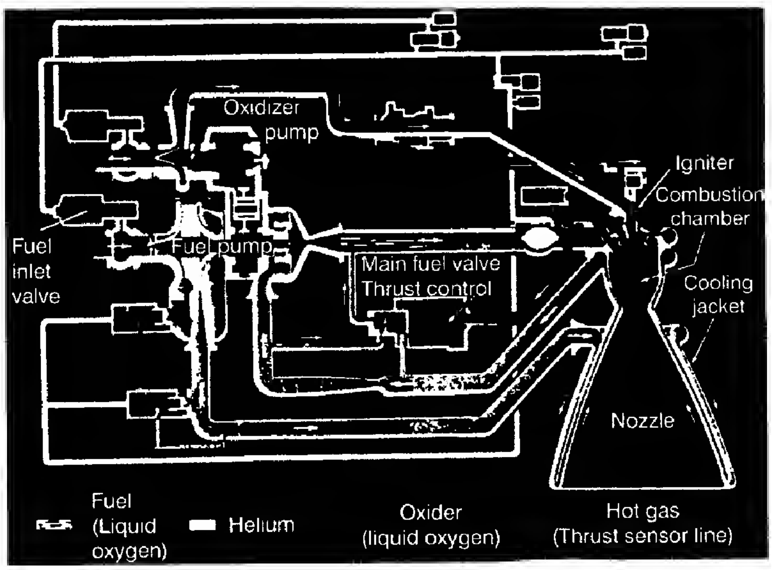


Fig.19.3. Combustion process in liquid propulsion.

VOCABULARY

redundant = excesiv
to cripple (r) = a schilodi, a deteriora
to feed - fed - fed = a alimenta
environment = mediu înconjurător

NOTES TO THE TEXT

WORD STUDY

I. **Rather, fairly, slightly**

It is important that propellants **rather than** helium to be transferred to the engine.
Rather, not ***fairly*** is used with comparatives, whether they indicate an advantage or a disadvantage.
The temperature in the boiler is **slightly** higher than it should be.
rather higher
slightly above normal
rather above normal
The temperature in the boiler is **normal** (500°C).
slightly normal
fairly high (=this is an advantage)
rather high (=this is a disadvantage)

II. **Bring about, Produce, Cause, Give rise to**

To force will **cause** the flowing of the propellant.
bring about
give rise to
produce

PATTERN

Difference

Be careful with the prepositions, which are used:
The propulsion systems are selected primarily on the basis of reliability
as opposed to performance.
as distinct form
unlike

The engine has six cylinders **as against** the four cylinders of the earlier one.
as compared with
as opposed to

The machine **differs** / **is different** from the other **in** its shape / several respects / that is more powerful
by its shape

It is useful to **differentiate** / **distinguish** / **make a distinction** between a blower and a liquid pump.

EXERCISES

I. Comprehension

Complete the following sentences:

One of the most critical systems on a spacecraft is …. If the propulsion fails …. The propulsion systems are selected primarily on the basis of … The avoidance of cryogenic propellants …. On manned spacecraft only … Compared to conventional pump feed propulsion systems, the pressure feed system …. Spacecraft are all equipped with .... It is common practice to carry …

II. **Give the Romanian** equivalents:

empty weight	*dynamic weightlessness*	*operational reliability*
all up weight	*extended weightlessness*	*maintenance reliability*
fuel weight	*prolonged weightlessness*	*overall reliability*
in-orbit weight		*vehicle reliability*
load factor weight		
weighted mean		
weightless		
payload weight		

III. **Complete these sentences** according to the pattern:

1. Jet aircraft can fly at supersonic or hypersonic speeds ... the 660 mph maximum speed of a propeller driven engine. 2. The low pressure compressor has four stages of compression .... the high pressure compressor, which has eight stages. 3. The petrol engine ... the Diesel engine ... the mixture is ignited in the cylinder by a spark. 4. ... the Diesel engine, the petrol engine is spark ignited. 5. We normally ... those substances which are good conductors of current and those which are not. 6. Heat waves ... light waves only ... their different wavelengths. 7. Conduction .... convection ... the way in which the transfer of heat is affected. 8. Iron ... rubber is a good conductor of electric current.

IV. **Re-phrase the sentences below** using the model:

It is (was) .... who (that, which)

1. This space vehicle must successfully carry out the launch manoeuvre. 2. Even though the rocket principle has been understood for many years, only recently rockets have been adapted as powerplants for aircraft. 3. Life could exist within this group of planets. 4. The combination of these two effects causes the slowing of the air current. 5. The shock wave begins to curve at this point. 6. In 1520 the Polish astronomer N. Copernicus showed that the Earth was a planet and it moves around the Sun. 7. Until 1946 man did not actually make radio contact with another body in the solar system. 8. The high speed flights brought about the introduction of the "ejector seat". 9. The space environment between 200 and 1,000 km from the surface of the Earth can be considered safe enough to establish stable orbits for the various types of space vehicle. 10. This very region will develop manned space flight in the near future.

V. **Translate into Romanian**, paying attention to the complex verbs:

1. Flight results must be accounted for. 2. In this report gravity is satisfactorily accounted for. 3. The idealized structure of the fuselage was finally arrived at. 4. After all these calculations the gravitational attractions of Mars must be dealt with. 5. The preflight inspection of the airplane was insisted upon by the flight engineer. 6. The high cost of the engine development was referred to at the beginning of this article. 7. Venus is sometimes referred to as the "twin planet" of the Earth. 8. The critical acceleration level is referred to as the "stability limit". 9. Liquid motion are generally referred to in the literature as capillary waves. 9. Such a device cannot be relied upon. 11. This rapid trajectory calculation can be relied

upon. 12. The equipment for this experiment was sent for. 13. The satellite defense problem was much spoken about. 14. The lunar exploration programme has been much written about.

VI. **Translate into English**:

1. Venus este acoperită de un strat gros de nori. 2. Climatul planetei Marte este destul de bine cunoscut. 3. Marea majoritate a avioanelor de azi sunt prevăzute cu trenuri de aterizare escamotabile. 4. Orice vehicul în spațiu este expus pericolului de coliziune cu meteoriți. 5. Satelitul a fost lansat pe o orbită circulară de 1500 km. 6. Baze permanente vor fi stabilite pe Lună şi pe Marte. 7. Racheta cosmică a fost lansată de pe un satelit la un punct determinat pe orbită. 8. Precizia sistemului de control a zborului a fost considerabil îmbunătățită.

20 Spacecraft Tracking and Guidance Supplementary Texts

An interplanetary flight demands the proper escape of the spacecraft from the departure planet, its injection into a transfer orbit, the required refinement of its coasting trajectory, and its ultimate capture by the target body. The spacecraft has to be launched at a time when the Earth and the target planet are in relative favorable position to reduce to a minimum the necessary booster thrust and the trajectory corrections of the vehicle. These launch opportunities occur only at certain synodic period: the time required for the relative geometry between the bodies to repeat itself. The parking orbit permits the spacecraft to travel to the correct location where a final impulse can accelerate it to the proper geocentric escape velocity.

Launch vehicle guidance system must be sufficiently accurate to limit later trajectory correction to comparatively small velocity changes. The corrections are made by using small rocket engines on the spacecraft, which it is possible to command from the ground in both duration and direct of thrust. As a result, the spacecraft can be directed into an arbitrary known orientation in space.

When the spacecraft has been injected into the transfer trajectory, it has to be oriented to establish the attitude or angular reference. Generally the sun is taken as first reference and either the Earth or a bright star as the second reference. On approaching the target planet, the vehicle enters the terminal phase of the trajectory. So as to obtain a soft landing, the spacecraft is equipped to measure approach velocity and altitude in a close-loop system that senses the landing surface and controls the deceleration and descent rate by firing throttleable rocket engines. A landing capsule is ejected and parachuted to the surface in the case of planets with atmosphere.

The navigation of a spacecraft through deep space demands the solution of three problems to hit the target: the launching trajectory, the post launch trajectory and the incremental velocity change. It is obvious that an electronic computer is indispensable; so is an accurate radio tracking system.

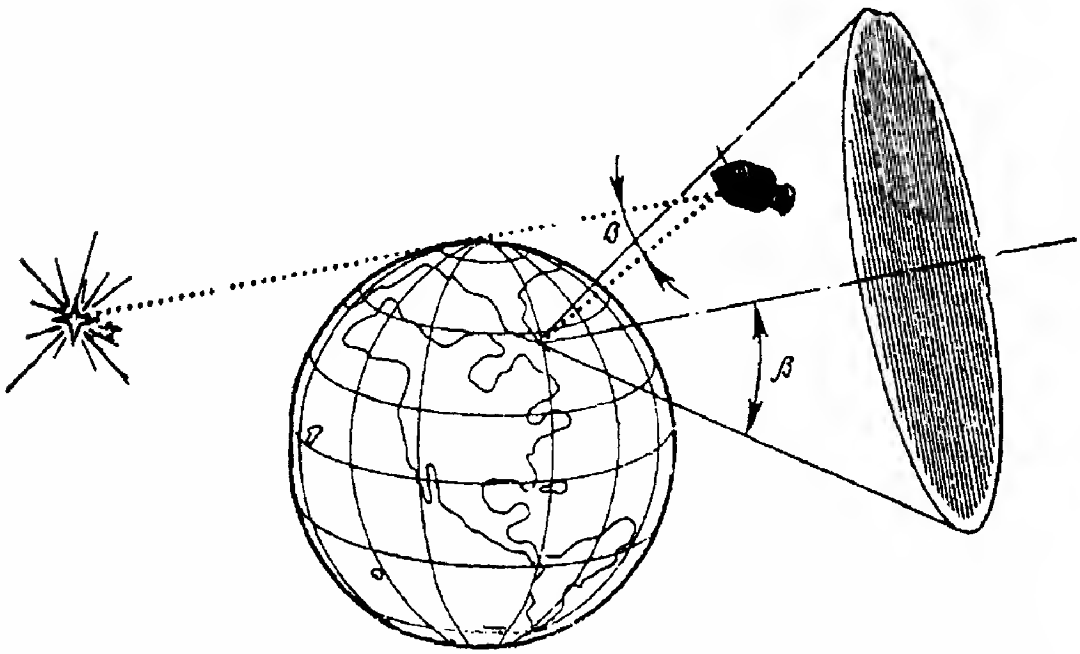


Fig.20.1. Radio communication system.

Radio communications from spacecraft to Earth and from Earth to spacecraft are needed for information and commands (fig. 20.1).

The navigational data supplied by the radio communication system comprise the angles of arrival of the signals from the vehicle, the range and velocity change of the spacecraft when a radio beacon is on board the vehicle. The Earth-based receiving antenna measures the direction of the spacecraft. Its large parabolic reflector is mounted so as to be steerable across the celestial sphere to follow the vehicle motion. The pointing direction of an antenna can be measured to an accuracy of approximatively 0.01 degree. Range is measured by timing the round trip signal from Earth to vehicle and from it to Earth. Its relative speed is measured by means of the observation of the Doppler effect between the radio frequency of the signal sent to the vehicle and that returned from the vehicle. Only atomic or molecular oscillators supply the order of stability necessary for the frequency source. Masers (Microwave Amplification by Stimulation Emission of Radiations) employing the element rubidium are capable of oscillating at 6 billion cycles/sec. They are accurate to one part in 100 billion over comparatively long periods.

Because space communication distance increase, the radio system bandwidth must be kept at a minimum consistent with the information rate of the data to be transmitted. Reception of weak radio signals with an acceptable noise level is achieved by means of solid-state maser amplifiers operated at low temperatures. So as to track spacecraft at planetary distances and recover data, the antenna has to be capable of tracking remote sources (fig. 20.2).

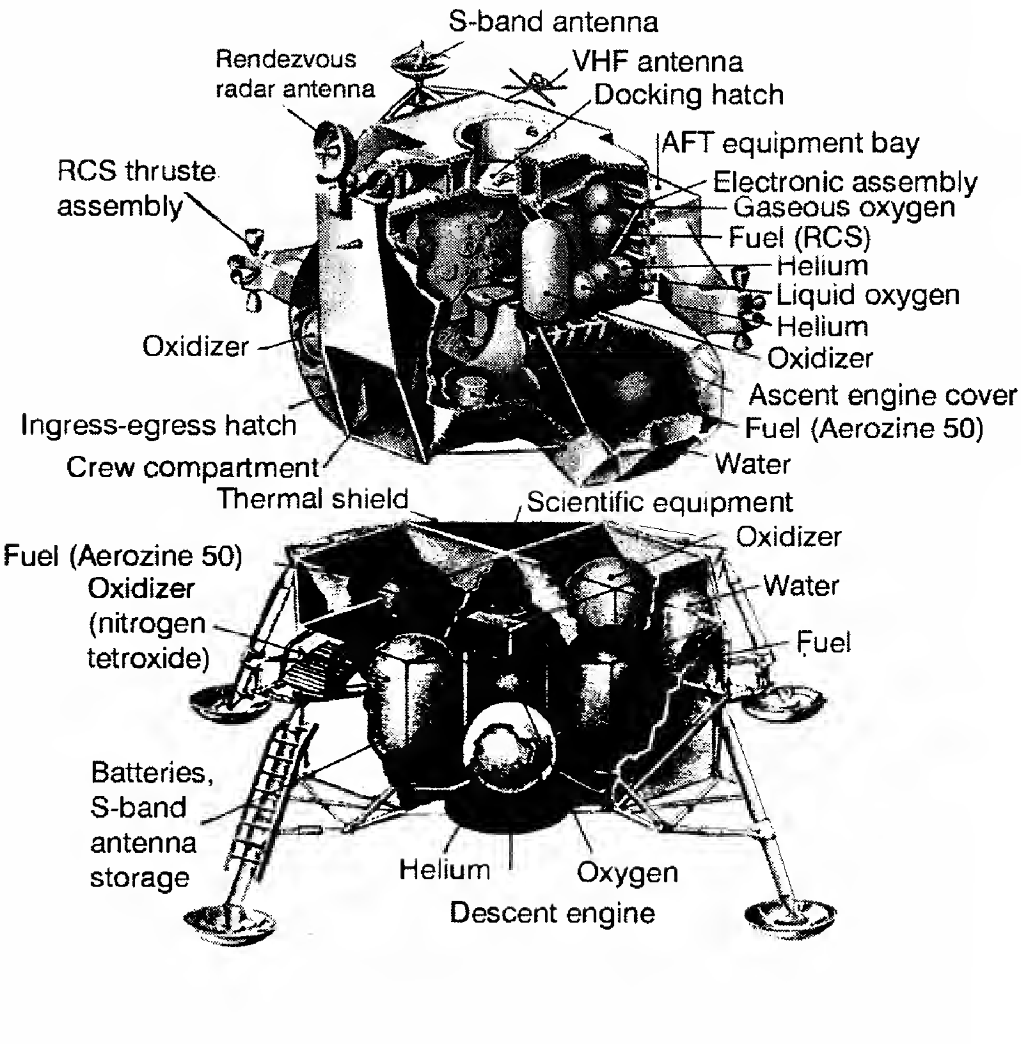


Fig.20.2. Lunar module.

Consequently, it has to collect the maximum of radio signal energy while rejecting electromagnetic and galactic interferences. A compromise must be found regarding signal-to-noise ratio, energy collecting area, beam width and angular accuracy. Closer and closer operating tolerances (critical tolerances) require accurate calibration procedures and the use of primary standards for measuring inductance, capacitance, voltage, frequency, timing, impedance and attenuation.

VOCABULARY

attitude = poziția aeronavei în spațiu
climbing attitude = panta de urcare
commanded pitch attitude = unghi de tangaj comandat
wing's level attitude = poziția avionului cu unghiul de înclinare
to sense (r) = a intui, a percepe
tracking = urmărire radar
beacon = far
to launch(r) = a lansa
open loop system = sistem cu circuit deschis
closed loop system = sistem cu circuit închis

NOTES TO THE TEXT

WORD STUDY

Parking orbit = path described by one body or object in its revolution about another;
one complete revolution of a body describing such a path

to orbit = to revolve in an orbit around, to circle;
to send up and make revolve in an orbit

to park = to land or leave an airplane;
to set and leave temporarily

PATTERN

Manner

The bridge was designed **so that** it would last forever.
This statement emphasizes the deliberate way or manner in which the results are brought about.
Other patterns for this type of statement:

a) The air drier ca be modified **in** | **such a way** that it fits the boiler.
modified **so** |
| as to allow it to fit inside the boiler
so modified |

b) The large parabolic reflector is mounted **so** as to be steerable across the celestial sphere to follow the vehicle's motion.

So as to obtain a soft landing, the spacecraft is equipped to measure approach velocity and altitude.

So as to track spacecraft at planetary distances and recover data, the antenna has to be capable of tracking remote sources.

EXERCISES

I. Comprehension

Comment on:

– interplanetary flight;
– spacecraft launch;
– launch vehicle guidance systems;
– navigation of a spacecraft;
– radio communications.

II. **Give the Romanian equivalents** for:

air - ground communication
ground - air communication
interplanetary communication
inter satellite communication
re-entry communication
satellite – to – satellite communication
ship to satellite communication
space to space communication

average data
design data
lunar data
launch research data
orbital data
planetary data

drag increment
impulse velocity increment
lift increment

all - the - way tracking
celestial radio tracking
deep space probe tracking
mid-course tracking
radar tracking
re-entry tracking
space tracking

III. **Complete these statements** following pattern I a:

1. The coolant circuit is (arranged) no radioactivity will pass into the generators. 2. The factory was (designed) there would be no waste of power. 3. The steam pipes must be (fitted) longitudinal expansion or contraction to take place. 4. The pressure vessel is (designed) it will withstand the blast of an explosion. 5. The reactor core must be (shielded) no dangerous radiations can escape. 6. The waste products are (stored) they cannot contaminate their surroundings.

IV. **Complete these sentences** from the Exercise III, using pattern I b. Useful verbs are "*to enable*", "*to prevent*".

> **Model** : *The pressure vessel is designed so as to withstand the blast of an explosion.*

V. **Notice the stress in verbs** and corresponding nouns:

con'tract	*'contract*
de'crease	*'decrease*
in'crease	*'increase*
de'tail	*'detail*

ex'tract	*'extract*
fore'cast	*'forecast*
im'port	*'import*
ob'ject	*'object*
per'fect	*'perfect*
pro'ject	*'project*
pro'gress	*'progress*
re'cord	*'record*
sub'ject	*'subject*
trans'fer	*'transfer*
trans'port	*'transport*

VI. **Translate into Romanian**, paying attention to the verbs plus prepositions:

1. Accounts should be taken of the boundary layer oscillations. 2. Advantage is often taken on the effect of the solar radiation. 3. Application should be made of this new design of the swept wing. 4. Attention has been drawn to some of more specific problems of the parachute recovery. 5. Attention will be given to the incompressible fluids. 6. Special attention has been paid to the laboratory investigations. 7. Care was taken to minimize the air drag effect. 8. Careful consideration was given to the selection of suitable vibration frequencies. 9. Emphasis is placed chiefly on the low frequencies. 10. Mention has already been made of the aircraft performances. 11. Provisions must be made to minimize the jamming of emergency exits in an airplane.

VII. **Translate into Romanian**, paying attention to the words underlined:

1. Science **affects** our life today and tomorrow. 2. The rotation of the earth **affects** the movement of the air. 3. Changes in air density **affect** the flight of an airplane. 4. Many factors **affect** the heating of a missile. 5. The airplane **approached** the runway and landed safely. 6. Under these conditions the Reynolds number **approaches** very large values. 7. When a spaceship **encounters** the atmosphere, the friction of the gas molecules against the surface of the ship generates heat. 8. The artificial satellite **entered** the Earth's atmosphere and burned. 9. At a preset time the artificial satellite **entered** the orbit around the Moon. 10. The re-entry phase of a space vehicle flight **follows** a ballistic trajectory. 11. The fluid **follows** the contour of the tank very closely. 12. The selection of the propulsion engine **influences** the over-all characteristics of the vehicle. 13. The previous reporter did not **mention** the following details of the inertial guidance

system. 14. The Moon **orbits** the Earth about once a month. 15. As the spacecraft orbits the Earth, the centrifugal force **balances** the force of gravity. 16. Unmanned spacecraft **rely** completely on automatic instrumentation to gather scientific data.

VIII. **Translate into Romanian**, paying attention to the modal verbs:

1. The aerodinamists **must have carried** out the aerodynamic analysis of the aircraft. 2. Some of the largest meteorites, such as the Sikhote-Alin meteorites of 1947, must **have had** masses of 70 tons or more when they entered the Earth atmosphere. 3. The meteorites that created some of the large crates, such as the one in Arizona, must **have been** even bigger. 4. The dark side of the Mercury **may have been** one of the coldest places in the solar system. 5. This situation **may have** produced some very interesting effects on the geology of the planet. 6. The pilot **may have lost** the control. 7. Viscous forces **may have** produced vortices. 8. As you **may have** learned at school, the speed of the sound in the air varies with the temperature. 9. Most students **may have** heard of the variety of ideas to produce artificial gravity.

21

Bac (BAC) ONE - ELEVEN

In May 1977, BAC concluded an agreement with IAR of Romania for the Series 475 and Series 500 to be built under license in Romania.

A One-Eleven "hush kit", comprising an intake duct lining, a by-pass duct lining, an acoustically-lined jet pipe, and a six chute exhaust silencer, was flown for the first time, on the Srs 475 development aircraft G-ASYD, on 14 June 1974. It is designed to reduce the area within the 90 EPNdB noise contour by approximately 50 per cent, giving a noise footprint equivalent to that of a twin-turboprop aircraft. The first production aircraft to be fitted with' hush kits' were the fleet of five One-Eleven 500s for Tarom, the Romanian state airline, which were delivered between March and August 1977.

The following description applies to the Series 475 and 500:

TYPE: Twin-turbofan short/medium-range transport.

WINGS: Cantilever low-wing monoplane. Modified NACA cambered wing section. Thickness / chord ratio 12½ % at root, and 11% at tip. Dihedral 2°. Incidence 2 °30. Sweepback 20° at quarter-chord. All-metal structure of cooper-based aluminum alloy, built on fail-safe principles. Three-shear-web torsion box with integrally machined skin/stringer panels. Ailerons of Redux-bonded light alloy honeycomb manually operated through servo tabs. Port servo tab used for trimming. hydraulically operated through Hobson actuators. Light alloy spoiler/air brakes on upper surface of wing, operated hydraulically through Dowty Paul actuators. Hydraulically actuated lift dumpers, inboard of spoilers are standard. Flaps on Series 475 have a glass fiber coating. Thermal de-icing of wing leading edges with engine bleed air.

FUSELAGE: Conventional circular section all-metal failsafe structure with continuous frames and stringers. Skin is made from copper-based aluminum alloy.

TAIL UNIT: Cantilever all-metal fail-safe structure, with variable incidence T tail plane, controlled through duplicated Hobson hydraulic units. Fin integral with rear fuselage. Elevators and rudder actuated hydraulically through Dowty Boulton Paul tandem jacks. Leading edges of fin and tail plane de-iced by engine bleed air.

LANDING GEAR: Retractable tricycle type, with twin wheels on each unit. Hydraulic retraction, nose unit forward main units inward. Oleo-pneumatic shock absorbers manufactured by BAC. Hydraulic nose wheel steering. Dunlop wheels, tubeless tyres and 5-plate heavy-duty hydraulic disc brackets. Hytrol Mk III antiskid units. Main wheel tyres size 40 x 12 in. Srs 500, pressure 11-03 bars (160 lb/sq in). Dunlop 44 x 16 tyres on Srs. 475, pressure 5,72 bars (83 lb/sq in). Nose wheel tires size 24 x 7.25 tires on Srs. 500, pressure 7.58 bars (110 lb/sq). Dunlop 24 x 7.7 tires on Srs. 475, pressure 7.24 bars (105 lb/sq in). All tyre pressures are given for aircraft at mid-CG position and max taxi weight.

POWERPLANT: Two Rolls-Royce Spey Mk 512 DW turbofan engines, each rated at 55.8 kN (12,550 lb st), mounted in pod on each side of rear fuselage. Fuel in integral wing tanks of 10,160 litres (2,235 Imp gallons) and centre section tank of 3,864 litres (850 Imp gallons) capacity; total fuel capacity 14,024 liters (3,085 Imp gallons). Optional 1,591 litres (350 Imp gallons and 3,182 litres (700 Imp gallons) fuel tanks are available to increase total fuel capacity. Pressure refueling point in fuselage forward on wing on starboard side. Provision for gravity refueling. On capacity (total engine oil) 13.66 litres (3 Imp gallons).

ACCOMODATION: (**Srs 475**): Crew of two on flight deck and up to 89 passengers in main cabin. Single class or mixed class layout with movable divider bulkhead to permit any first/tourist ratio. Typical mixed class layout has 16 first class (four abreast) and 49 tourist (five abreast) seats. Galley units normally at front on starboard side. Coat space available on port side aft of flight deck. Ventral entrance with hydraulically operated air stair. Forward passenger door on port side incorporated optional power operated airstair. Galley service door forward on starboard side. Two baggage and freight holds under floor, fore and aft of wings, with doors on starboard side. Entire accommodation air-conditioned.

ACCOMODATION (**SRS 500**): Crew of two on flight deck and up to 119 passengers in main cabin. Two additional over wing emergency exits, making two on each side. One toilet on each side of cabin at rear. Otherwise generally similar to Srs 475.

SYSTEMS: Fully duplicated air conditioning and pressurization systems with main components by Normalair-Garrett. Air bled from engine compressors through heat exchangers. Max pressure 207 bars (3,000 lb/sq in), operates flaps, spoilers, rudder, elevators, tail plane, landing gear, brakes, nose wheel steering ventral and forward airstairs and windscreen wipers. No pneumatic system. Electrical system utilizes two 30-kVA Plessey/Westinghouse AC generators, driven by Plessey constant speed drive and starter units, plus a similar generator mounted on the APU and shaft-driven. AIResearch gas turbine APU in tail cone to provide ground electrical power, air-conditioning and engine starting, also some system checkout capability. APU is run during take-off to eliminate performance penalty of bleeding engine air for cabin air-conditioning.

ELECTRONICS AND EQUIPMENT. Communications and navigation equipment generally to customers' individual requirements. Typical installation includes dual VHF communications equipment to ARINC 546, dual VHF navigation equipment to ARINC 547 A, including glide slope receivers, maker receiver, flight/service interphone system. Marconi AD 370, Bendix DFA 73 or Collins DF 203 ADF. ATC transponder to ARINC 532 D. Collins 860 E2 DME. Eko E 190 or Bendix RDR IE weather radar. Sperry C9 or CL 11 compass systems and Collins FD 108 flight director system (dual) are also installed. The autopilot is the Elliott 2000 Series system and provision is made on the Srs 500 for additional equipment, including automatic throttle control, for low weather minimum operation.

DIMENSIONS, EXTERNAL (Srs 475, 500) :

Wing span	28.50 m (93ft 6 in)
Wing chord at root	5.12 m(16 ft 95/8 in)
Wing chord at tip	1.65 m (5 ft 5 in)
Wing aspect ratio	8.5
Length overall : Srs 475	28.50 m (93ft 6 in)
Srs 500	36.61 m (107 ft 0in)
Lentgth of fuselage: Srs 475	25.55 m (83 ft 10in)
Srs 500	29.67 m (97 ft 4 in)
Height overall	7.47 m (24 ft 6 in)
Tail plane span	8.99 m (29 ft 6 in)
Wheel track	4.34 m (14 ft 3 in)
Wheel base : Srs 475	10.06 m (33 ft 0 in)
Srs 500	12.60 m (41 ft 4 in)

Passenger door (fwd, port)	
Height	1.73 m (5 ft 8 in)
Width	0.82 m (2 ft 8 in)
Height to sill	2.13 m (7 ft 0 in)
Ventral entrance: Height	1.83 m (6 ft 0 in)
Width	0.66 m (2 ft 2 in)
Height to sill	2.13 m (7 ft 0 in)
Freight door (fwd, starboard):	
Height (projected)	0.79 m (2 ft 7 in)
Width	0.91 m (3ft 0 in)
Height to sill	1.09 m (3 ft 7 in)
Freight door (rear, starboard):	
Height (projected)	0.66 m (2 ft 2 in)
Width	0.91 m (3ft 0 in)
Height to sill	1.30 m (4 ft 3 in)
Freight door (fwd, Srs 475 SOAF)	
Height	1.85 m (6 ft 1 in)
Width	3.05 m (10 ft 0 in)
Galley service door (fwd, starboard)	
Height (projected)	1.22 m (4 ft 0 in)
Width	0.69 m (2ft 3 in)
Height to sill	2.13 m (7 ft 0 in)

DIMENSIONS, INTERNAL (Srs 475)

Cabin, excl. flight deck	
Length	17.31 m (56 ft 10 in)
Max width	3.16 m (10 ft 4 in)
Max height	1.98 m (6 ft 6 in)
Floor area	approx.47.0 m^2 (506 sq ft)
Freight hold, fwd	10.02 m^3 (354 cu ft)
Freight hold, rear	4.42 m^3 (156 cu ft)

DIMENSIONS, INTERNAL (Srs 500)

Cabin, excl. flight deck	
Length	21.44 m (70 ft 4 in)
Total floor area	approx.61.78 m^2(665 sq ft)
Freight holds (total volume)	19,45 m^3(687 cu ft)

AREAS (SRS 475, 500)

Wings, gross	95.78 m^2(1,031 sq ft)
Ailerons (total)	2.86 m^2(30.8 sq ft)
Flaps (total)	15.89 m^2(171 sq ft)
Spoilers (total)	2.30 m^2(24.8 sq ft)

Vertical tail surfaces (total)	10.90 m^2(117.4 sq ft)
Rudder, incl tab	3.05 m^2(32.8 sq ft)
Horizontal tail surfaces (total)	23.90 m^2(257.0 sq ft0
Elevators, incl. tab	6.55 m^2(70.4 sq ft)

WEIGHTS AND LOADINGS:

Operating weight empty:	
Srs 475	23,348 kg (51.473 lb)
Srs 500	24,454 kg. (53.911 lb)
Max payload : Srs 475	9,764 kg. (21.527 lb)

22 Dallas / Fort Worth Airport

Dallas airport is situated on the North Texas plains, midway between the cities of Dallas and Fort Worth, being expected that this new airport will set new standards for design and construction of airports throughout the world. Although discussions for a regional airport to serve the two cities took place at intervals since 1927, the first concrete plans were not drawn up until 1965. A 7000 ha site was chosen for the airport construction at a position some 27 km from both Dallas and Fort Worth and work began in December 1968. The 27 square mile site is larger than Manhattan Island and would be able to hold New York – John F. Kennedy, Chicago – O'Hare and Los Angeles International Airport without any difficulty.

The planned principal airfield system actually provides two separate and independent runway systems for commercial airline operations. Each half of the 6 km long central terminal complex separated by a central spine roadway is served by two parallel north-south runways and a crosswind runway. The two outboard north-south runways, planned for initial length of approximately 4,075 m, each incorporate reserve areas for future extensions up to 6,100 m. The two crosswind runways are planned for length up to 3,400 m. Paved overrun areas, 300 m long are provided at each end of all six principal runways. In addition, a 1,500 m business aviation runway is planned in the eastern sector of the airport. Separated 1,500 laterally from the principal runway system, it can, when necessary be utilized in conjunction with the east crosswind runway.

A further runway system located in the airport's western sector is provided for Stol traffic. This consists of a 750 m north-south runway with 1,500 lateral separations and one 750 m crosswind runway with 1,070 m lateral separation oriented approximately parallel to the principal runway

system. It has been assumed by the planners that the two outboard north-south runways will be used primarily for aircraft landings during peak periods of air traffic activity, while the two inboard runways are to be reserved for take-offs. All principle runways are planned with a system of high speed taxiway turnoff, whilst conventional right angle taxiway turnoffs are planned for locations where low speed aircraft ground traffic is anticipated, such as taxiways leading to the maintenance areas and air cargo terminals.

Dallas / Fort Worth Airport has more than 230 aircraft gates in 13 semi-circular terminals, accommodating an estimated 100,000 passengers daily, which brings special problems of transportation around the complex. To overcome this, a people mover system, Airtrans, developed by LTV Ground Transportation Division has been installed. This system utilizes 40-passengers, rubber-tired vehicles that move along concrete guideways. The electrically powered vehicles are programmed so that the average ride time from one point on the airport to any other point is eight to twelve minutes. In the opening phase of the airport there were 53 stations on the Airtrans system served by 51 "people moving" vehicles and 17 utility vehicles. The 20 km route has gradually been expanded as the airport developed. Annual figures for the Airtrans system were 14 million in 1975 and 26 million in 1980. In 1970, Dallas – Love Field, which currently served both Dallas and Forth Worth, emplaned 5-6 million passengers and 15 million in 1987.

Four terminal half-loop structures, with a total of 66 passengers gates and the two inboard runways are put into service. These are capable of handling 8 million passengers annually. Each complete passenger terminal loop is able to handle 18 high capacity aircraft or up to 22 conventional aircraft. The airport's capacity will be steadily expanded to meet increased traffic, the final plan envisaging 13 passenger terminals, permitting 234 Boeing 747 aircraft to be parked simultaneously and handling more than 50 million passengers annually.

Car parking areas are incorporated in each terminal so that passengers will have very short distances to cover – in many cases they will be able to park within 100 m of the aircraft they wish to board.

Traffic flow through the terminal complex is very simple. The high degree of decentralization removes the need for extremely complicated and extensive baggage handling system. The emplaning road leads departing passengers directly to curbside baggage drop-off and check-in facilities. Passengers proceed up escalators to departure lounges along the loop

concourses. The Airtrans system is through each terminal loop at ground level to transfer passengers and service modules to key stations adjacent to aircraft gates and airline operation area. At a later stage it is envisaged that an intercity rapid transit system will connect the central district of Dallas and Forth Worth with the airport.

If one compares current traffic at Dallas Love Field, the population of Dallas / Forth Worth region and that of the State of Texas (a little over 10 million), one could easily come to the conclusion that in planning the new airport, the Texas passion for doing everything on the largest scale possible has been given free rein. Three development stages had been established by the Airport Board for years 1975, 1985 and 2001.

23 "A Small Problem"

They had just finished eating, and the 87 passengers and crewmembers aboard Trans World Airlines Flight 841 settled back for the last leg of their trip from New York to Minneapolis. In the cockpit, Capt. Harvey (Hoot) Gibson, 45, had the fourteen-year Old Boeing 727 trijet on autopilot. But at 39,000 feet over Flint, Michigan, the plane suddenly began the shake, then veered hard right, nosing downward into an ever-steeper dive and at least one violent 360 degree barrel roll. Cabin fixtures broke, glasses flew through the air and panic erupted. "People started to scream and a flight attendant was crying", recalled Utah college student (Bell Roberts, 22).

Rolling like a fighter plane and picking up so much speed that it apparently broke the sound barrier, the 727 plummeted about 24,000 feet in less than a minute as it headed toward the flat Michigan farmland below. Passengers and crew were pressed into their seats as if by a giant hand. In the restroom, passenger Barbara Merrill prepared to die. "The noise got louder and louder and the whole plane was shaking", she said. Locked in, she was pinned to the compartment floor. "I said, 'Oh, God, I'll never make it'" – then the door flew open, and she fell into the aisle. 'I screamed for help and then I couldn't draw another breath", she said. "My lungs wouldn't expand".

LAST-DITCH TACTIC: As Gibson struggled desperately to regain control, the airspeeds indicator neared Mach 1 – about 660 mph at that altitude. He deployed flaps, air spoilers and slats on the leading edges of the plane's wings. The maneuvering finally righted the aircraft, but nothing could slow the dive. Finally, he ordered copilot Scott Kennedy to lower the landing gear, a latest ditch tactic to increase the jet's drag. It worked - "may be two second before crashing, "Gibson said. With flaps drooping and fuel leaking from a ruptured wing tank, the 727 leveled off at about 10,000 feet.

Gibson bulled the 727 toward Detroit Metropolitan Airport, about 60 miles to the southeast. "Let's face it", he told his dazed and prayerful passengers, "we've had a small problem, but we seem to have it under control". But Flight 841's time of terror was not over: the right wing was damaged, and no one knew if the battered landing gear would hold up. As the plane approached the field, fire trucks and ambulances were waiting. Said passenger Merrill: "All I could think after all we'd been through was, we'll crash on impact and burst into flames". All aboard prepared for a crash landing, but it never came. Gibson, fighting a new tendency by the 727 to veer left, landed hard but smoothly. Six people reported bruises.

Flight 841 survived because the aging 727 was very well built "strong as a brick", said Langhorne Bond of the Federal Aviation Administration – and because Gibson was a very good pilot. "I can't think of any other incident where a commercial, passenger carrying plane has done a 360 degree rollover and survived", Bond said. Gibson's not in the manual maneuver of lowering the landing gear was apparently the key. "It comes down to doing the right thing at the right time", said Gibson, who has logged 23,000 hours in the air since he first learned to fly at the age of 14.

MYSTERY TAPE: Investigators were somewhat mystified to find that a tape recording of cockpit conversation during the incident had apparently been wiped clean. But they expected to dope out the cause of the near disaster with the help of the sealed in-flight recorder that monitored the plane's instruments. Some passengers, however, had already reached a verdict. Offered a connecting flight from Detroit to Minneapolis, one man said no, rented a car and drove the rest of the way.

24 Indelible Lesson

The numbers alone are exciting. That was my thought as I began assembling the various pieces for this issue on high technology trends in our corner of aviation. Aviation technology is literally feeding off itself: one new product leads to another that offers the user more flexibility, greater efficiency and additional gadgets, often in a small package and at less cost. Where is all this leading?

Another look at the numbers is a good indication. Commercial aircrafts are incredible in what they can do today. The loads they can lift, the distances they can fly, the efficiency they have achieved and all while becoming, mile for mile, perhaps the safest form of travel. But tomorrow will be even better. The technology is coming. It may be on the drawing board or it may be an undefined, abstract cogitation in some engineer's mind. But it is coming.

While it's easy to get excited over all the new gadgets and electronic wizardry, we still need to remember something: they do only what we "tell" them to do. They have to be used properly if they are to serve us and keep us out of harm's way.

This lesson was indelibly etched on my consciousness several years ago while on a flight in a friend's all – the options Piper Aerostar. His color weather radar indicated that the cloudbank we were approaching was thin and friendly. Second later, however, the windscreen was iced over and we were blown around like the peas. A look out the side window wasn't very comforting either; ice was forming on the wings, engine inlets and props. After we finally managed to break into the clear, we began searching for the gremlin in the weather radar.

The gremlin, however, was my friend's bad aim – he had pushed a wrong button, setting the radar's slant upwards instead of straight ahead. His aim was considerably better in finding the switch to turn on the wing deicers and making all the other adjustment to get us out of there.

Technology, improperly employed, had led us into trouble; but more technology had helped us to get out of it.

25

Sneak Attack

A July morning in Philadelphia; the wind is calm, the sky clear. Even at seven o'clock the air is balm. Air Pennsylvania Flight 501, a Piper Navajo, contacts Philadelphia Approach Control as a VFR pop-up. Inbound from Reading on a regular morning run, the airplane is carrying only one passenger. The pilot reports at 3,500feet 14 miles out, squawk ident and is instructed to report over downtown Philadelphia. His landing sequence is number four, behind a United 727 on a curving final approach for runway 27. The copilot of the Navajo reports the 727 in sight, and continues the approach. The jet touches down; two miles behind it, the Navajo swings from a wide base leg onto final, coming in low and flat. The Navajo is less than a mile from the runway threshold, and probably about 200 feet above the ground, when its flight suddenly becomes erratic. It banks steeply first one way, than the other, and then rolls inverted and plunges into the ground beside the end of the runway. The three men aboard are killed, and the aircraft is demolished.

It is immediately evident that the culprit was wake turbulence. What is not so obvious is why the encounter took place, and what could have been done to prevent it.

Wake turbulence is left behind by planes as a swell is left behind by boats. There is no known way to eliminate it, but its behaviour is well documented and understood.

If airplanes have wings of infinite span, there would be no wake turbulence. It is produced by air squirting out beneath the wing and then spilling up into the low-pressure area above the wing. The weight of the airplane is what does the squirting. If the airplane is light or fast-moving, the wave rolling up from beneath each wing tip is small in diameter and has less force than if the airplane is slow, heavy or both. The airplane is gone by the time the wave raised by the wing has had time to curl around the wing tip; the wave rolls itself into a tube and keeps spinning, forming a vortex, or

rotating tube, like a tornado or like the tube of water that whirls above the bathtub drain. Once set in motion by the passing airplane, these twin tornadoes, one spun off each wingtip, continue rolling for some time before the viscosity and turbulence of the atmosphere drain away the energy.

All airplanes produce tip vortices. Even in the wake of the smallest homebuilt, there may be vortices of surprising force. The strengths of those generated by heavy jets on final approach is tremendous; vortex velocities have been measured at 133 knots. Jets have been known to crash in the vortices of jets. The danger is greatest when the vortex field is large in comparison with the wingspan of the airplane encountering it. Since the vortex field behind an airplane eventually occupies an area two wingspans in width and one wingspan in height, it is easy to see that a relatively small airplane like a Navajo is no match for the football-field-sized wake of even a small airliner.

There is a general sinking of air behind a passing airplane; if you view a jet in profile as it approaches a runway, you can see that its exhaust smoke sinks below its flying path. Tip vortices also settle at about 500 feet per minute behind the airplane that generated them, leveling out about 900 feet below the flight path. If the vortices get within 200 feet of the ground, they move outward, propelled by the air drawn into the space between them from above. The entire vortex field is carried along by the surface wing;. but since the vortices move apart at about five knots, the upwind vortex may remain stationary in a light wind or even travel upwind. A light crosswind, therefore, might keep a vortex spinning right on the runway.

Most fatal vortex encounters occur in the vicinity of airports, because airplanes are brought into close proximity with one another, because they are moving slowly, so producing strong wakes, and because airplanes closed to the ground have the least chance of recovering safely from an upset produced by a wake encounter.

It is not necessary to be following an airplane to encounter its wake; you might collide with the wake of an airplane operating on another runway if it recently passed over your flight path. But, because of the sinking of wake vortices, encounters on an ILS approach are unlikely. Each airplane, so long as it does settle far above the glidepath, is kept well above the wake of the one preceding it. Given this information, it is easy to see that the best way to avoid vortex turbulence is to fly above and upwind of the flight path of heavy, slow aircraft. It is also easy to see that the pilot of Flight 501 made an error in approaching low and flat behind the 727. The descent path of the Navajo was only two thirds as steep as that of the jet; and although for the most part the Navajo remained to one side of the jet's wake, a vortex encounter was almost certain once it lined up on final below the jet's three degree glide path.

Since vortices are produced in proportion to aircraft weight, an airplane whose wheels are on the runway produces less of a wake than one that is airborne. But after rotation or before the nosewheel is lowered to the runway, the wings are still supporting some weight of an aircraft. A pilot sequenced to land behind a heavier aircraft should therefore note the point not only of the touchdown, but also nosewheel contact, and land beyond both.

Taking off behind a heavy aircraft, you should be airborne before the point at which the other aircraft rotated, and should turn aside, upwind if possible, before there is another chance of flying through the vortex produced by the climbing aircraft. Exhaust smoke of jet engines may give some indication of the area to avoid.

A pilot is entitled to refuse a take off or landing clearance if he feels it will bring him dangerously close to another airplane. But the pressure not to do so can be great at busy airports, where somebody else will take the slot if you don't; you may feel that you'll never get where you're going if you're not willing to flirt with a wake encounter.

It is sometimes suggested that acrobatic training might be helpful in a wake turbulence encounter. No doubt a pilot who had been upside down before and knew how to recover would have been a better chance of getting right side up again if he found himself inverted on short final. But, quite apart from the pilot skills, there are limits to the power of ailerons. An airplane caught in a vortex spinning more rapidly than the airplane roll is momentarily powerless: for what it may be worth, the best way to roll out of a violent wake encounter is probably with the vortex - reaction that is not the most natural one for pilots. Those pilots who daily share runways with heavy jets may become complacent about wake turbulence. One dallies with it so often, and is touched by it so rarely, that it may begin to seem less of a threat than it is claimed to be. Perhaps it was the bad luck of flight 501's crew to have been luckier before, and so, to have lost respect for the invisible breakers rolling behind the jets with which they hobnobbed every day at Philadelphia. Perhaps they imagined that staying below the United 727's flight path would keep them clear of its wake; if so, they had greatly misunderstood wake turbulence.

Standing beneath the path of landing jets, you can sometimes hear in the air, minutes behind them, an eerie sound like the snapping of the whips or the flapping of invisible laundry in the wind. It is the crackling of the vortices at play. What makes it weird is its persistence and its invisibility; the sounds seem to come out of thin air long after the airplane has passed.

26 Helicopters Electronics

Electronics currently account for around one third of the cost of a helicopter, the units ranging from straightforward radio communication system, through autostabilization equipment, fly-by-wire controls and microwave landing systems specifically designed to cater for problems on an aircraft able to land in a "hole of a wood".

The future trend in helicopter electronics can be summed up in a single word "consolidation". This means quite simply that the prime need is to keep costs down, to go for simplicity rather than great sophistication, and to concentrate on producing equipment which will carry out its function reliably and effectively.

The fundamental component for helicopter autopilots and flight control system is the autostabilizer system. Helicopters are inherently instable devices and it is necessary to monitor attitude continuously, applying suitable control movements to maintain a given attitude and course. This control activity can impose a considerable workload on the pilot, particularly in turbulence or when operating at low levels in poor visibility, when attitude information must be derived largely from flight instruments, backed up by the pilot's "seat of the pants' input".

An example of the latest such systems in the Automatic Flight Control System is an advanced helicopter design with semi-rigid rotor. The major characteristics of this type, according to the manufacturer, are its high control power and response, the near purity of control and the immediate response to control movements.

The system designed for the Lynx provides duplex stabilization in four axis-pitch and roll stabilization is based on vertical gyros with the rate gyros to provide stability in the yaw axis. The fourth axis is an innovation

based on a strapped-down accelerometer mounted vertically on the axis of rotation of the main rotor. This latter feature provides stability in the vertical (collective) axis and is designed to overcome the effect of changes of incidence on the hingeless rotor, with the effect of changing the thrust of the rotor along its axis of rotation. This Collective Acceleration Compensation is of particular value in providing good control over the complete performance range.

The complete AFCS for the Lynx operates on a series/parallel arrangement of actuators, with limited "authority" in series and full "authority" in parallel.

All control movements from the autostabilizer have a low authority to enable the pilot to over-ride them in the event of failure. At the same time, the low authority autostabilization provides fast control to overcome the effects of turbulence. Low authority stabilization provides a "fail soft" control system in which the pilot has 100% authority under normal conditions and even under a complete failure mode, he retains 90% authority over the control system When the autostabilization system is engaged, the series actuators operate to provide stabilization, but do not move the pilot's controls.

However, when an autopilot is engaged a separate trim actuator carries out the autopilot control command in parallel with the high authority. This actuator moves the pilot's appropriate helicopter controls, cyclic sticks or yaw pedals or collective lever, to restore the series actuators to their centre position, after which they operate to provide autostabilization in the new flight attitude.

A triple redundancy philosophy has been adopted. This provides a fail-safe capability if one channel develops a fault and a fail soft characteristics if a second channel is lost. Faults are identified by comparisons between three data lanes, and rejected on the basis of a major vote. All three lanes are identical and will operate on the same input information derived from triplicated gyro units. Provision is being made for further development of the basic autostabilization system to incorporate all of normal autopilot modes with guidance coupling facilities, navigation computing and flight director coupling.

The basic heading reference in all aircraft is the magnetic gyro-compass in which a directional gyro provides a highly stable short-term reference, with a magnetic detector unit, which senses the direction of the horizontal component of the earth's field, providing a long-term reference through a slaving system.

The directional gyro used, for example, in the Westland Wessex Sea King and Lynx helicopters is the Sperry CL11. The gyro itself is electrically driven with its spin axis in the horizontal plane, and with freedom to move about a horizontal axis at right angles to this, and also about a vertical axis. The spin axis of the gyro is brought into the horizontal plane by a liquid levelling switch, which uses gravity to sense the vertical.

The overall drift of a modern gyro of this type is of the order of 10 per hour and the magnetic reference is used largely as a check on this long-term drift. Rotation of the earth will, of course, produce an apparent drift in the gyro, but this can be calculated precisely for any given latitude, and compensated for by a small torque applied to the gyro to generate a procession equal and opposite to this effect. A magnetic variation control is also provided to enable the compass output to be related to magnetic or "true" North, as required. It can also operate independently, as a directional gyro.

27 Powering the Vertical Risers

In the decade and half which have followed the first flight of the Hawker P 1127 and successful demonstration of the feasibility of jet by powered vertical take-off and landing (VTOL), the miracle has not come to pass and the concept has not became an accepted part of the mainstream of aviation technology. During the 1960's we were treated to an extensive procession of real and paper aircraft for a wide variety of uses.

By 1975, the economic and logistic demands of the VTOL operations had effectively pushed them out of the reach of civil sector and limited their military utility. In raw terms, the cost of doing away with a runway was beyond most people pockets. In addition, advances in short-take off and landing (STOL) and rough-field operational capability have made the jet VTOL concept appear much less attractive in reality than it did in theory. A considerable amount of development work has been done. Only two powerplant systems, simple enough and reliable to stand the test of intensive use, have materialized. In the first, the same engine provides both lift and forward flight thrust, through a system of exhaust deflection.

The Hawker Siddeley Harrier employs thrust vectoring, with swivelling nozzles to deflect fan air and the exhaust downwards, while Rockwell's XFV-12 A uses the Thrust Augmented Wing, where engine air is diverted to the aircraft's wing and canard surfaces and exhausted through large lateral nozzles.

The second system involves the use of separate engines for lift and cruise flight, although in practice the cruise power unit may also incorporate thrust vectoring. Both systems have proven effective, although neither is an ideal solution and both have inherent draw-backs: all jet VTOL aircraft need "puffers" at their extremities-wing-tips, nose and tail-through which bleed air is blown for stability at low speeds and in hovering flight. Engine downwash under these conditions can cause ground erosion, exhaust gas

reingestion and control problems. In the final analysis, with all the technology available, the ultimate success of any existing VTOL aircraft depends on a high degree on the pilot skill.

Powerplant Concepts

The key to any successful jet-propelled VTOL aircraft is the powerplant because of the very high thrust – to weight ratios required from an engine for vertical lift.

In terms of simplicity the Harrier's Pegasus installation is the least complicated of all but the concept has the disadvantage of not being easily adapted to afterburning, which is essential if Mach 2.0 type performance is to be achieved. There is no doubt that the aircraft is excellent at low speeds and for hovering with the thrust vectoring nozzles providing a "four-poster" effect, aided by "puffers" in the nose, tail and control surfaces.

Rolls Royce is working on its "plenum chamber burning" system to provide the thrust augmentation obtained from afterburning in a conventional engine.

For VTOL, dry thrust will be used and the engine air will be exhausted through "augmenters" in the wings and canard fore planes. This has the effect of drawing ambient air through the augmenters giving an eight-fold increase in airflow because of the eductor effect. For every pound of engine air passing through the system, about eight pounds of ambient are drawn in, which gives a thrust augmentation ratio of about 1.6:1, and a useful vertical lift of up 9,000 kg (20,000 lb). For high-speed forward flight, the ducting to the wings and canards is closed and the engine functions in the conventional way, with afterburning possible.

So far, nobody else has proposed a jet VTOL aircraft with afterburners. The two most important thrust-vectoring programs at present are the Harriet/Pegasus combination and the Yakovlev Yak-36. The latter differs essentially from the Harrier in having two engines and only two vectoring nozzles.

It is thought that the definite aircraft utilizes a vectored-thrust/direct lift mixture. Hawker Siddeley remains firmly wedded to the vectored-thrust system. The chosen instrument is the Rolls Royce Bristol Engine Division Pegasus, which originated as a turbofan derivative of the single shaft Orpheus engine.

Besides the addition of a front mounted fan and a low-pressure turbine on a second shaft (counter-rotating) shaft air from the outboard portion of the fan is collected and discharged through a pair of lateral nozzles about midway along the engine, while the hot gases from the rear of the Pegasus are also discharged through a pair of lateral nozzles. All four nozzles can be swivelled-vertically downwards for actual VTOL, rearwards for forward flight and forwards for braking, plus any intermediate position.

Basically, the Pegasus 11 comprises a three stage fan, an eight-stage compressor, annular combustor, two-stage high pressure and two stage low-pressure turbine; inlet diameter is 122 cm, and length 348 cm, while weight without the fan and exhaust air nozzles is 1,392 kg. Total Pegasus running time is now about 120,000 hours.

28 Electrical Systems

Airplanes use electrical power for many essential services. On transport aircraft, both alternating and direct current supplies are required. A surprisingly large part of the total electrical power requirement for long-range commercial aircraft is in the galley. The required electrical capacity is greatly increased by the requirement for safety and dispatch ability.

Safety and reliability lead to the requirement of multiple separated electrical systems with the ability to transfer load between them so that no single fault can cause loss more than one generator channel and no combination of two faults can cause the loss of the primary electrical power. In addition secondary power systems are provided. Furthermore the above requirements must be met even with any one generator inoperative to permit dispatching the airplane without delay when one generator is not working.

In designing electrical systems, alternate combinations of generator capacities and numbers and locations of generators are studied along with the alternate possibilities of variable speed/constant frequency units, constant speed drives, and random frequency concept.

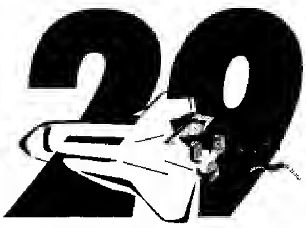
At the present state of the art constant speed drives (CSD) powering 120/208 volt 400 Hz alternating current generators are typical for the proven systems in services. For the DC-10 the primary system consists of one such 90 kW generator mounted on each of the three propulsion engines. The system is supplemented by a fourth generator on the auxiliary power unit (APU), batteries for short term emergency use and a drop-out air turbine driven generator for long-term emergency use. A 28-volt direct current supply is derived from the a.c. system by transformer-rectifiers. The system is designed to permit airplane dispatch with a generator and/or the APU inoperative to increase operational reliability.

An important design consideration of the generators is cooling since generator life, or KVA capacity for a given life is dependent upon temperature. The generator output rating, in this case 90 KW, is based on generator cooling air at 120 C.

The battery is used for refueling and engine starting to provide power, control circuits and instrumentation without requiring external power. The electrical system is automatic in operation, each generator carrying a proper load except in case of a malfunction. In that case, protective relays disconnect the offending system until the flight crew can determine corrective action by study of the annunciation indications.

The protection system provides protection against short circuits, open circuits, over and under voltage, over and under frequency, over and under excitation of the generators, unbalanced current, and incorrect phase sequence.

The control and instrument panels on the most recent aircraft are arranged to represent a simplified schematic diagrams so that the flight crew can more readily understand the operation and nature of any indicated fault.



Travellers' Tales

Every year a magazine called 'Executive Travel' organizes a competition to find the Airline of the Year. Travellers from all over the world are invited to vote for the most efficient, the most punctual, the safest and the friendliest airline. The winner in 1985 was British Airways. The competition asked travellers what for them was most important from an airline, and the results were as follows:

Punctual departures and arrivals	35%
Attentive cabin staff	35%
Comfort	18%
Safety	9%
Good food and wine	3%

The competition also invited travellers to tell their most horrific stories of the nightmare side to international travel. Replies included six hijacks, fifty-three cases of engine failure or trouble with the landing gear, eleven lightning strikes, twenty-three bomb scares, thirteen cases of food poisoning, eleven near misses and two collisions with airport trucks.

Bad flying experiences begin on the ground, naturally. One American airline managed to double-book an entire 747, but this is nothing compared to what happened on an international flight on a certain African airline. The flight had been overbooked three times. The local military sorted the problem out by insisting that all the passengers with boarding cards should run round the plane twice, the fastest getting the seats.

An overbooked flight that was going from Heathrow to America gave one traveller a bit of shock. Dressed only in trousers, shirt and socks, he had been allowed by the stewardess to leave the aircraft to see if he could get a colleague aboard. He returned a few minutes later to find the 747

closed up and about to start moving-with his shoes, wallet, passport and lugagge inside. Banging frantically on the door got him back inside.

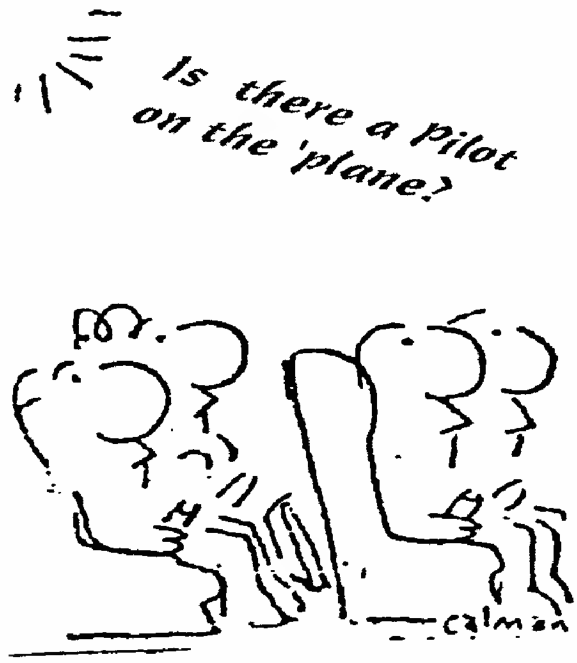
A similar event was seen by a businnesman on a flight from Bangladesh. Passengers were waiting for take-off when there was sudden hysterical hammering on the door. At first the cabin crew paid no attention. The hammering continued. When the door was finally opened, the pilot got in.

One frequent flier lost a certain amount of confidence when the cabin staff asked him to sit in the lavatory during take-off, so that they could occupy the seats nearest the emergency exit. Another lost faith in the pilot's navigational skills when passengers were given lifeboat drill on a flight between London and Manchester.

For nervous fliers, a journey to be avoided was one between Gatwick and Monpellier, where the in-flight entertainment consisted of watching pieces of the engine falling off.

Another passenger was asked to hold the aircraft door closed at take-off and landing.

Baggage is a rich source of horror stories. There was the unlucky traveller who left Chicago in minus 23 weather. He was going to an important meeting in Dallas, where the temperature was 80-plus. Unfortunately his suitcase had gone to LA, where it spent the next two days. The customers he was trying to impress were more than a little surprised to see him going round in a thick suit, heavy overcoat and fur hat.



30 Mechanically Controlled Actuation Systems

The use of the power actuators to position aircraft flight control surfaces started when airplanes reached a size where the pilot was unable to comfortably apply sufficient force to control the aircraft. They were first used on the heavy transport aircraft designed in the late 1930s and early 1940s.

Hydraulic actuators, rather than some other type, are used for many aircraft actuation functions (e.g.. landing gear retraction, steering, brakes, etc.) simply because of the high forces that can more easily be developed with high pressure hydraulic cylinders than with other forms of power conversion. For positioning flight control surfaces, however hydraulically powered servomechanisms are used primarily because of their controllability and performance rather than simply their power capability. For safe flight, it is absolutely essentialy that pilot at all times maintains authority over those flight control surfaces to control the aircraft.

Other Primary Control Surfaces

In addition to the basic primary control surfaces, there are other types used on certain aircraft configurations to provide control to meet the pitch, roll, and yaw maneuvre demands.

Variable-Incidence Horizontal Stabilizers

For pitch control, where an elevator surface would be of inadequate size, the horizontal tail is often rotated on an axle by one or more large

hydraulic servo-actuators. On transport aircraft, such as the Boeing airliners and their military aircraft derivatives, the stabilizer is used for pitch trim. Its use eliminates the need for deflecting the elevator for trimming and thereby avoids a significant drag increment. On the Lockheed L-1011 airliner, the stabilizer is positioned by four servo-actuators, each supplied by one of the aircraft's four hydraulic systems.

Variable-Camber Horizontal Stabilizer

A double-hinged stabilizer can provide an increase in surface camber to increase its effectiveness. Such a stabilizer with four very large hydraulic servo-actuators was planned for the Boeing Model B2707-300SST, and was tested on a full scale "iron bird" flight control system simulator which validated the design and operation of the "geared" stabilizer.

Canards

Pitch control surfaces can also be placed on the forward fuselage as canards. These can be a fixed surface with a trailing-edge control surface or the whole canard surface can rotate on an axle and be controlled, or it can be allowed to 'float' to seek its own trim position.

The Wright brothers' use of a forward elevator on their first aircraft, after testing horizontal surfaces both ahead of and behind the wing, was because the forward position offered better control and would avoid the nose dives that killed other aviation pioneers. With the pilot in a prone position, this surface could be quickly raised or lowered by hand. Later, such surfaces became known as canards (from the French) or entes (from the corresponding German expression) for the fancied resemblance to the appearance of a duck in flight.

The canard concept was emulated by many of the other early designers but was soon supplanted by the rear horizontal tail which, due to its inherent static stability, has since predominated and become the more conventional approach.

However, over the succeeding years, a number of aircraft have been designed with tandem wings and/or canards. These include both military and civil types. One of the most notable is the Swedish Viggen Mach-2 supersonic fighter. Its double-delta configuration has a delta main wing with trailing-edge elevons and a canard wing with trailing-edge elevators.

Elevons

An elevon is a wing trailing-edge surface which functions both as an elevator for pitch control and as an aileron for roll control. They were first used on tailless delta-wing aircraft which had no horizontal tail to accommodate a conventional elevator. They are now seen as a very effective and efficient means of providing pitch and roll control on high-performance fighter aircraft.

The modern use of the delta wing is found in supersonic aircraft with a long flight-range requirement. A leading edge with high sweep angle is needed to minimize high-speed drag, and the pointed-tip delta wing is the most efficient fuel carrier.

The elevons on typical tailless delta-wing aircraft are actuated symmetrically like elevators for pitch control, and asymmetrically like ailerons for roll control. These aircraft typically have a vertical tail and rudder, and no flaps. Without flaps, landings are at very high angles of attack to obtain the necessary lift at low speed, which requires very long landing gear struts to avoid tail strikes.

Stabilators, Stabilons, and Tailerons

These surfaces (the names are synonymous) are actually the two halves (left and right) of the main horizontal stabilizer. Both halves operate symmetrically like a single-piece stabilizer for normal pitch control, and differentially (asymmetrically) for roll control to augment the ailerons and/or spoilers. On swing-wing aircraft such as the F-111, F-14, and B-1, when the wings are swept aft into the "glove" cavity, the ailerons and/or spoilers are deactivated and the differential tails provide the sole means for roll control. With the wings swept forward, the ailerons and/or spoilers are activated and operated in conjunction with the differential motion of the tails.

Flaperons

On some aircraft, the functions of the ailerons and the trailing-edge flaps are combined. The flaperons are operated symmetrically as flaps and asymmetrically as ailerons.

Spoilers

For lateral control, often more than one set of ailerons or other surfaces are used to meet the required aircraft roll rates. For instance, some Boeing airliners are equipped with inboard ailerons which are active at all flight speeds, and with outboard ailerons which are active only at low speeds. On all large aircraft starting with the B-52, multiple upper-wing spoilers are used to augment the ailerons. These surfaces are used to spoil lift, and when controlled asymmetrically about the longitudinal axis cause a rolling moment in the direction of the raised spoiler.

Spoilers provide additional roll control without inducing wing twist to cause the reversal. In addition, they also provide other advantages. They can be extended symmetrically in flight as speed brakes for making emergency descents; as direct-lift surfaces during approach where, with all spoilers partially extended, wing lift can be increased or decreased by operating the spoilers; and as ground speed brakes to dump lift during landing rollout to get maximum weight on the landing gear wheels, which will achieve maximum wheel braking and provide maximum drag to minimize the rollout distance.

Multiple Rudders

For yaw control, where a single rudder would be inadequate or unacceptable, either two or three vertical stabilizers with associate rudders can be used. Some twin-rudder aircraft were the World War II Convair B-24 and North American Aviation B-25 bombers, and the Beechcraft C-45 cargo transports which were later produced as business aircraft. Modern examples include the Lockheed SR-71 Mach-3 reconnaissance aircraft, the Grumman F-14 and the Mc Donnel F-15 and F/A-18 fighters.

Aerodynamic Trim Control Surfaces

Aerodynamic trim tabs were originally used for trimming an airplane for straight and level flight during cruise with hands and feet off the controls. These small auxiliary control surfaces are hinged to the trailing edge of the host control surface, to produce control movements active on the host control surface.

Trim tabs can become control tabs. With balance tabs, the control linkage is connected directly to the structure to which the control surface is

attached. Pilot movement of the cable control system is directly applied through the cable quadrant or torque tube to the control surface. This motion serves to move the balance tab in the opposite direction of the main control surface, and, like a control tab, aids in deflecting the surface thereby reducing the control loads felt by the pilot.

In addition, with the advent of powered control surface actuation systems, antibalance tabs also come into use. This type differs from the control tab and balance tab in that, rather than lowering the surface hinge-moment load, it increases it. More importantly, however the antibalance tab increases the effective camber of the control surface, making a more effective aerodynamic control surface.

31

Boeing Urges Stabilizer Inspections

Boeing, the manufacturer of the Alaska Airlines MD-80 that crashed after experiencing horizontal stabilizer difficulties, will urge airlines to inspect the mechanism after the discovery of a damaged part from the wreckage

Boeing planned to send out a letter by today to all its customers, said a federal aviation official who asked not to be named. Alaska Airlines and American Airlines announced inspection programs earlier Wednesday.

The action was prompted by a 2-inch-thick screw device found damaged on the ocean bottom. Known as a jackscrew (fig. 31.1), the electrically driven device controls the tail-mounted horizontal stabilizer, which raises and lowers the jet's nose.

Investigators are trying to determine whether the damage happened before the crash January 31 or as a result of it.

The jackscrew moves the stabilizer in much the same way that a common electric garage-door opener functions. When it turns, a nut attached to the long, threaded shaft moves, which lifts or lowers the front of the stabilizer.

The horizontal stabilizer on Flight 261 had malfunctioned by moving by itself to its furthest position, pushing the jet's nose down, before jamming.

The jackscrew found in the wreckage was broken on its lower end, and part of the shaft was wrapped with metal shavings, which might indicate that the nut's threads were stripped, the National Transportation Safety Board reported.

Federal Aviation Administration spokesman Eliot Brenner, referring to Boeing's action, said: "This is the right and prudent thing to do."

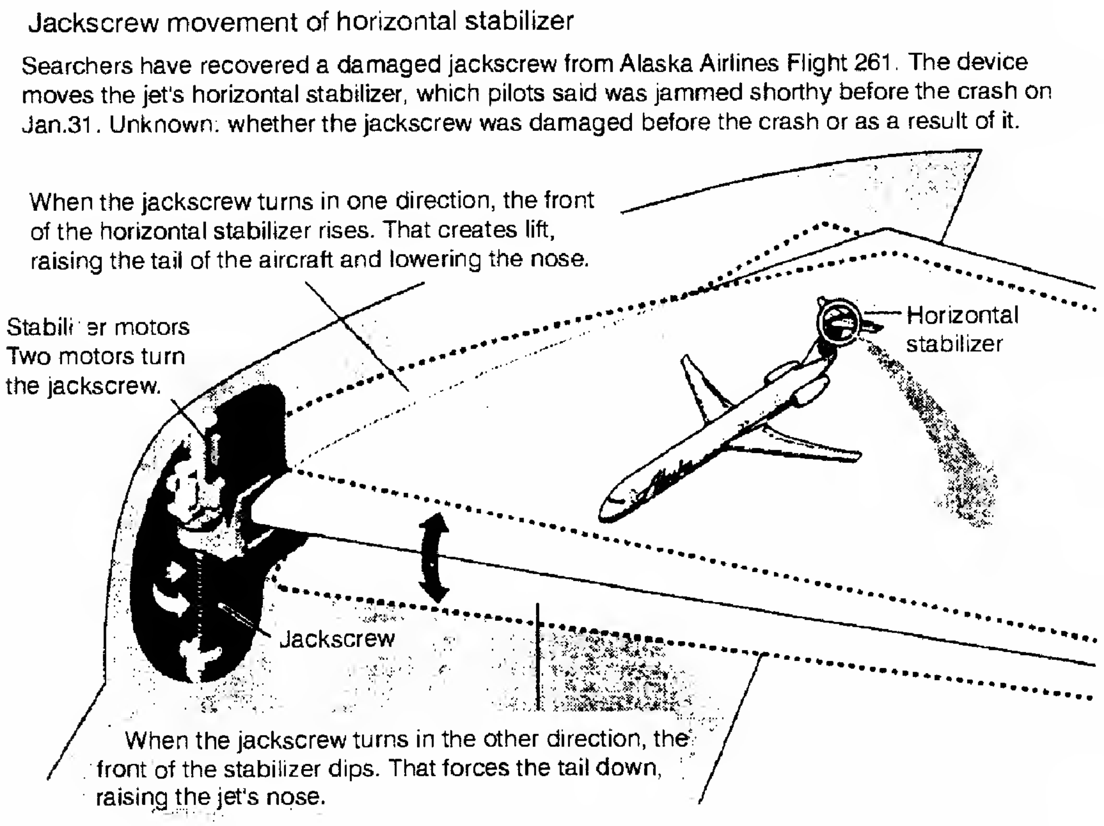


Fig.31.1.

Some airlines began inspecting the device before Boeing acted. Alaska Airlines announced earlier Wednesday that it would inspect its 34 MD-80s by this morning.

"At this point, no problems of any kind have been discovered", Alaska Airlines spokesman said Wednesday night.

American planned to take a week to complete inspections of its 284 MD-80 and similar MD-90 jets.

NTSB Chairman James Hall said a metallurgist from the safety board was examining the damaged part Wednesday. "If it was before the impact, then it is very significant what caused the crash," Hall said.

Flight 261, which departed from Puerto Vallarta, Mexico,on its way to San Francisco and Seattle, dived into the ocean about 10 miles off the California coast after the pilots battled a stabilizer jam for over 30 minutes. All 88 aboard died.

The jet dived from cruise altitude after the stabilizer moved into a position that forced the nose down, the NTSB said. The pilots regained

control of the aircraft, but as they were prepared to land, the jet dived again, flipped onto its back and fell into the Pacific. Investigators want to know whether the damage to the jackscrew could indicate that the stabilizer went beyond its normal limits. If it did, the movement could have prompted the jet's final plunge.

The damaged jackscrew prompted federal officials to inspect other MD-80s to determine whether there could be a systemic problem with the stabilizer system.

The MD-80 and its nearly identical predecessor, the DC-9, are the second-most-popular commercial jetliners in the world and have a good, 35-year safety record.

Federal records show little evidence that the jackscrew has been a problem.

Maintenance records list five instances during the past ten years in which the jackscrew played a role in stabilizer problems on the family of jets. All the problems were spotted during inspections, and none appears to have caused in-flight difficulties.

32 Plane Accidents

The main causes of plane accidents are forced landings in unsuitable locations (sites), unskillful landings, too violent maneuvres, uncommonly strong gusts of air, flutter trouble and aerodynamic instability. Forced landings may result from motor failure, fuel exhaustion, fuel leakage … Among unskillful landings there are ground loops resulting from piloting mistakes during downwind or crosswind landings and unskillful landings due to a defective arrangement of wheels or undercarriage while taxiing. Very violent maneuvres include spins, dives, loops, rolls, flick rolls … Wings may be broken by up-gusts; down-gusts may break the tail surfaces or throw the aircraft against the ground.

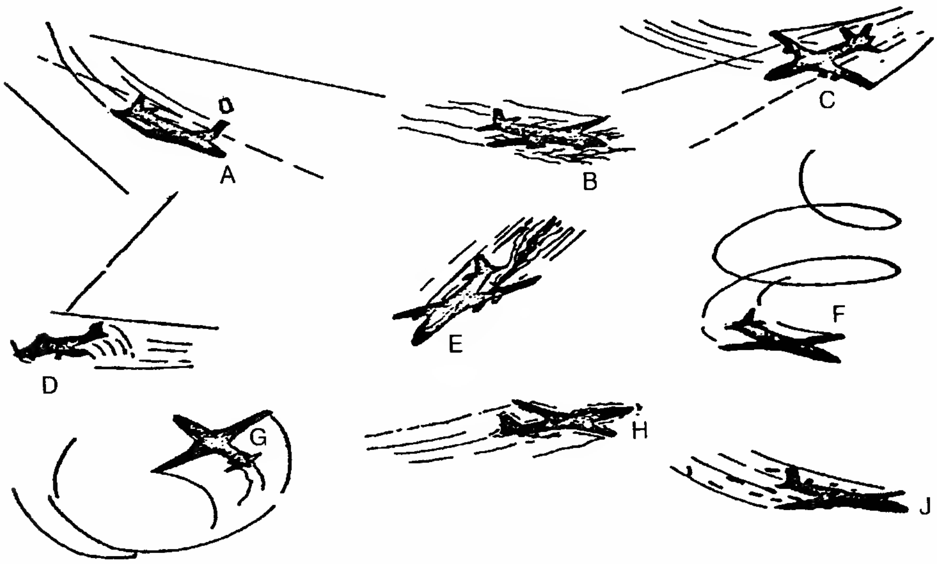


Fig. 32.1. Plane accidents:
1–Unskillful landing crash; 2–Forced landing; 3–Strong gusts of aer; 4–Ground loop; 5–Fuel leakage; 6—Spin; 7–Loop; 8–Flutter trouble; 9–Motor failure.

33 Electrical Power Generation in Space

There are a great many uses for electrical power on board a manned spacecraft. Power is used by communications equipment, by the radar, navigation and guidance equipment, and by the automatic control system. The environment control system uses electricity to drive the blowers that circulate oxygen in the cabin and through the space suits of the crew, and then through purification and cooling equipment. Cooling fluids must be circulated past heat-producing equipment and then through external radiators. In other words, virtually every piece of equipment aboard the spacecraft consumes some electrical power.

Electrical energy can be produced aboard a spacecraft from chemical, nuclear, or solar energy. Invariably, the conversion of energy from the raw source into usable electrical power involves processes that are not 100 per cent efficient. This means that the amount of energy obtained in electricity is less than the amount of energy taken from the source. The difference between the useful energy output and the raw energy input is excess heat that cannot be used (in other words, waste heat). Since waste heat must be rejected from the spacecraft, the amount of waste heat produced in the power generation system may be a significant consideration in the selection and design of the system.

The simplest form of electric power supply is primary cells, more commonly called storage batteries. The energy source in primary cells is in the chemical properties of the cell materials. When the electricity is withdrawn from a battery, which is a series of cells, a chemical reaction takes place within the individual cells. The chemical energy is converted into electricity as ions flow from the cathode to the anode in each cell. The energy that produces this current is obtained from chemical reactions taking place between the electrodes and the electrolyte in the cell.

Batteries are quite efficient in converting chemical energy to electrical energy. Very little waste heat is produced, and that which is produced can be easily disposed of by regular spacecraft cooling system. Unfortunately, the best storage batteries do not store a great deal of available energy per pound of weight.

For duration in excess of a few weeks, chemical power systems are not competitive with systems based on nuclear or solar energy. This is because solar energy systems require no fuel at all, and nuclear systems require only a very small amount of fuel. Solar energy systems suffer from the basic requirement that the energy collection system must be positioned so that it can receive energy from the sun. This not only imposes an extra duty upon the attitude control system, but also restricts the freedom to manoeuvre. On the other hand, nuclear energy systems may require heavy shielding to protect the crew from harmful radiation.

Nevertheless, technology has advanced to the point where it is practical to build systems that could supply electrical power to manned spacecraft for periods in excess of one year using either solar or nuclear energy. Manned space laboratories and interplanetary spacecraft will undoubtedly be equipped with power systems using one or other of these energy sources.

The most straightforward way to use solar energy is by photo-voltaic conversion using solid state devices (solar cells). Such solar cells need only be exposed to sunlight to produce electrical energy. While only a small portion (perhaps six per cent) of the solar energy falling on a cell may be converted into electrical energy, the simplicity and lightness of the solar cell, as well as the abundance of solar energy in space, make this an attractive way to provide power aboard a spacecraft. Waste heat is not a problem since each cell is able to act as its own radiator

To supply adequate power for a large spacecraft will require thousands upon thousands of individual cells. This great number of cells will allow the use of circuit arrangements that should continue to provide adequate power in spite of the failure of individual cells or groups of cells during the lifetime of the spacecraft.

Solar energy can also be concentrated by a parabolic mirror and focussed as a heat source. The thermal energy thus obtained may then be converted to electricity by one of the numerous methods.

The most practical way to use nuclear energy to produce electricity is to convert the nuclear energy into thermal energy. Heat can be generated

by a nuclear reactor or by the use of the energy created by the decay of short half-life radioisotopes. Nuclear reactors suffer from the handicap of requiring very heavy shielding. If there is a need for large quantity of power, as might be the case if electric propulsion is employed, then nuclear reactors may be the most practical means for power production.

In comparison to a nuclear reactor, there are several attractive features found in the use of radioisotope fuel. Radioisotopes release energy at a steady but slowly decreasing rate without any need for control, and without the danger of a runaway reaction. Power generation systems using isotopes that decay with alpha emissions require little or no special shielding, since alpha particles have very little penetration capability..

Another advantage is that there is no special restriction on the size of the power-generating unit that can be constructed. The heat output and therefore the power level is dependent upon the activity level of the particular radioisotope employed, and the mass of the radioisotope constituent in the fuel charges. Thus, small, lightweight, compact power generation systems are feasible using radioisotope fuel.

The main problems associated with the use of radioisotope fuel are associated with the fact that the fuel charge cannot be 'turned off'. It starts producing heat from the moment it is manufactured. This means that it should be manufactured only a short time before it is to be used, otherwise it will deplete itself as the quantity of radioisotope mass remaining becomes reduced through radioactive decay. And of equal importance is the fact that from the time the fuel charge is manufactured, it relentlessly releases heat that must be removed. This not only complicates storage, but also is very bothersome once it becomes installed in the spacecraft, which may be a significant time before launch.

Both the nuclear reactor and the radioisotope fuel charge are heat producers. To convert the thermal energy produced, these heat sources must be used in conjunction with a heat sink (a cold region providing a means for dumping waste heat from the energy conversion process). In space, the only practical heat sink is a thermal radiator.

It can be seen that, with a variety of methods to choose from, suitable electrical power systems can be developed for future spacecraft regardless of size and mission.

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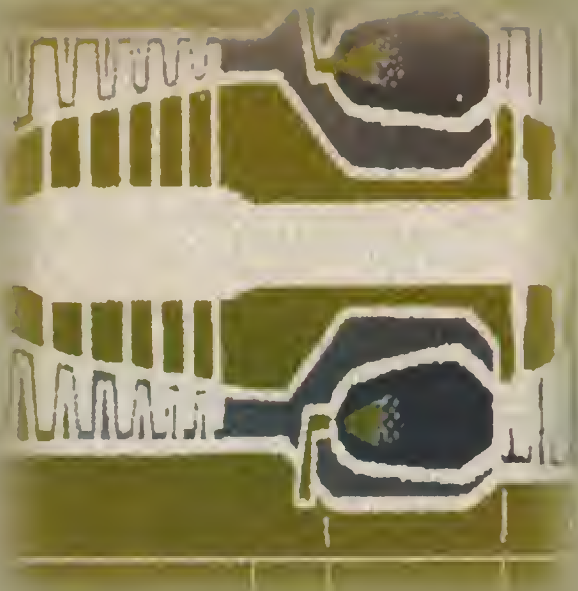

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